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COVER: Alpaca in the Andean altiplano (Photo: Government of Peru).

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ALPACA RAISING IN THE HIGH ANDES

by Saúl Fernández-Baca

The raising of alpaca is an industry of great value to the economies of some Latin American countries, notably Peru and Bolivia. Because of their great adaptability alpaca are able to utilize the grasslands of the Andean altiplano at altitudes over 4 000 m above sea level, where it is unprofitable to raise either sheep or cattle.

Alpaca can also be raised at lower levels. There is evidence that during the Inca empire they were more widely distributed than at present. With the introduction of sheep and cattle by the conquistadors, alpaca were subsequently confined to marginal areas unsuitable for these new species.

The main products obtained from alpaca are the wool (usually called alpaca fibre to differentiate it from sheep's wool), the flesh, used as meat, and the skins. The fibre is highly prized by the textile industry and its price on the international market is usually two to three times that of sheep's wool. The meat tastes like mutton and is the only source of protein of animal origin for the people of the Andean plateau. The skins, taken from lambs less than three months old, are used for a wide range of handicrafts: in the making of floor carpets (*alfombras*), quilts (*colchas*), slippers (*zapatillas*) and dress coats (*casacas*).

Peru, with some 2.9 million head, is the leading producer of alpaca. Next comes Bolivia with 300 000 head, while Chile and Argentina have a few that are of no economic significance. It is estimated that 80 percent of the alpaca in Peru belong to small owners and campesino communities and the rest to middle-class owners and associations that have emerged as a result of land reform. At least 200 000 campesino families depend in one way or another on the raising of alpaca.

In view of the economic importance of this species particular emphasis is currently placed on increasing its fibre and meat production through appropriate breeding programmes. Research during the last 15 years has provided considerable knowledge of different aspects of the anatomy, physiology, reproductive biology, health and nutrition of alpaca, thus laying the necessary foundation for technical advancement of their husbandry.

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Origin of alpaca and allied species

The alpaca, *Lama pacos* (Linnaeus), the llama, *Lama glama* (Linnaeus), the guanaco, *Lama guanicoe* (Müller) and the vicuña, *Vicugna vicugna* (Molina), form the group known as South American or New World camel-like or cameloid species. The alpaca and llama are domesticated and economically the most important. The llama is the larger of the two, adults reaching weights of around 120 kg and yielding a coarse fibre ranging in colour from white to black with all the intermediate hues or combinations of one or more colours. The meat is relished by the campesinos. The llama is also used as a beast of burden in Argentina, Bolivia, northern Chile and Peru.

The alpaca is smaller than the llama, adults weighing about 70 kg; its fibre

P. ORLANDINI

The two types of alpaca: Suri (above) and Huacaya (right)

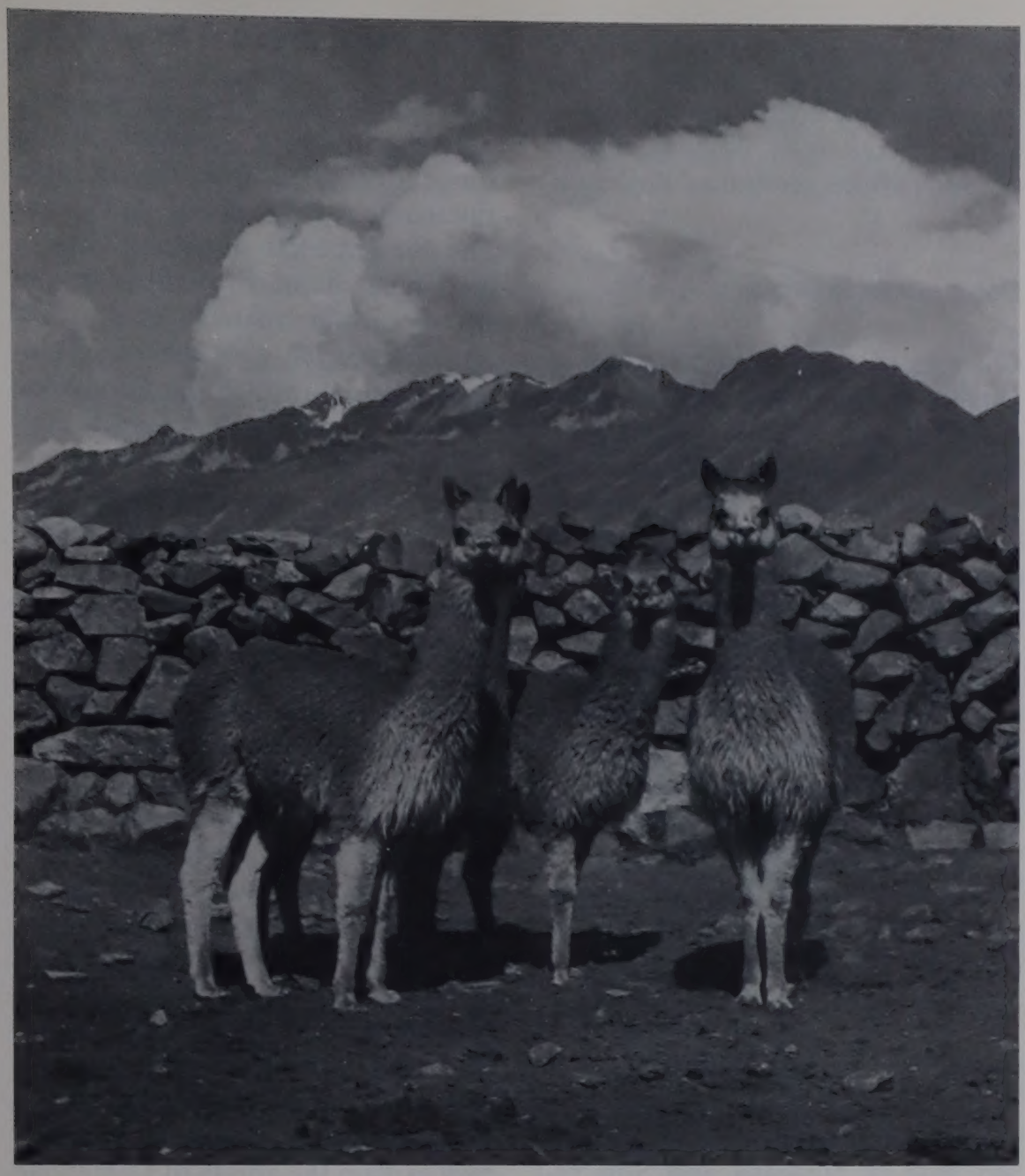
or wool is finer than that of the llama but has a similar range of colour. The guanaco and vicuña are wild species, the guanaco resembling the llama except for the colour of the fibre, which is a uniform reddish brown. The vicuña is the smallest of all in size, the adults weighing 35-40 kg.
There is frequent crossing among South American cameloids. The most frequent hybridization is between llama and alpaca, the cross being called *huarizo,* while that between alpaca and vicuña is called *paco-vicuña.* Both of these are fertile, probably because of the similarity of the parental karyotypes. Table 1 provides a summary of the distribution and number of South American cameloid species.

Breeds of alpaca

There are two types of alpaca, the Suri and Huacaya. The fundamental difference between them lies in the length and fineness of the fibre. The Suri have very long fibres, usually attaining lengths of over 15 cm in one year's growth, which form ringlets and fall to the side of the body, giving the animal a similarity in appearance to a Lincoln sheep. The Huacaya have a more compact fleece, with shorter fibres, and are similar in appearance to Corriedale sheep. From the standpoint of textile quality, the Huacaya fibre is best. There is no notable difference in body weight between the two types. When Huacaya are bred inter-se, about 2 percent Suri type animals are obtained, while the breeding of Suri animals gives about 17 percent Huacaya types. As a rule on commercial ranches there is a predominance of Huacaya alpaca, although no selection in favour of this type is practised.

Behavioural characteristics

Both the alpaca and llama exhibit certain behavioural characteristics which differentiate them from other domestic animals. They defecate and urinate in circumscribed areas, even if allowed freedom of movement to other places. This habit is very important in the control of internal parasites. Nevertheless to avoid deterioration of the pasture, distribution of the faeces is a necessary task. Another habit of the alpaca is to make use of communal areas as dust baths; under continuous use, these areas soon become barren and serve as places for the spread of ectoparasites, mainly itch mites of the Sarcoptidae family. The habits of spitting and trampling are probably defence mechanisms of the animals against outside aggression, real or potential. Their mating behaviour, described below, also differentiates them from other domestic animals.



Paco-vicuña, the hybrid obtained from the artificial insemination of alpaca with vicuña semen

Recent research on the biology of reproduction (Novoa, 1970; England *et al.*, 1969; and Fernández-Baca, 1970, 1971) of these cameloid species indicates that they differ from most known range animals. The most striking features relate to puberty, seasonality of breeding, oestrus and ovulation, sexual behaviour, fertilization, embryo mortality, gestation and parturition.

Reproductive characteristics

PUBERTY

Ovarian activity in alpaca may begin as early as 10 months of age. As with other species, the level of nutrition has a marked influence on the inception of puberty. Females 12 to 14 months old exhibit sexual behaviour, ovulation, fertilization and embryonic survival similar to that in multiparous females (Fernández-Baca *et al.*, 1972a). They can therefore be bred at one year of age under good conditions, at a body weight of about 40 kg (Novoa *et al.*, 1972).
Males one year old can be used for service; however in most of them at that age the penis sticks to the prepuce. In practice males are used as sires from the age of two to three years.

BREEDING SEASON

Alpaca, like other animals of their kind, are considered to have seasonal sexual activity. Thus on commercial ranches, even if males and females live together all year round, births occur only during the rainy season from December to March, when feed is abundant. But when males are kept separate from the females and are brought together solely for mating, it is possible to obtain young all the year round (Fernández-Baca *et al.*, 1972a). This means that continuous association of the sexes produces an inhibiting effect on the sexual activity of the male (Fernández-Baca *et al.*, 1972b). These observations are of particular importance in the handling of animals at breeding time.

OESTRUS AND OVULATION

Alpaca show no well-defined cyclical sexual activity. In contrast to ewes and cows, alpaca are always in the follicular phase so that until they are served they are in a constant state of oestrus. Ovulation is induced by copulation, occurring approximately 26 hours after the coital stimulus (San Martín *et al.*, 1968). Ovulation can be also be induced by the injection of chorionic gonadotropin (HCG), in which case it occurs approximately 24 hours afterwards.
Table 2 shows the effect of various types of stimuli on the induction of ovulation in alpaca (Fernández-Baca *et al.*, 1970a). It can be seen from this table that the introduction of the penis provides the necessary stimulus for the freeing of gonadotropin and subsequent ovulation.
However, not every service induces ovulation, since about 20 percent of females with active ovaries do not ovulate in response to single or multiple services by uncastrated or vasectomized males. In contrast, all females respond by ovulation to the administration of chorionic gonadotropin; thus the failure to ovulate as a consequence of natural mating is due to the deficiency in level of the luteinizing hormones. There are indications that nutritional factors may affect the secretion of this hormone and consequently the incidence of ovulation. The failure to ovulate may be one reason for low fertility. However, females that do not ovulate after first service can be served again and again as they continue to be in oestrus.

Although multiple ovulation occurs in approximately 10 percent of the cases, no multiple births have ever been recorded for alpaca. Only during the first month of gestation has the presence of two live embryos been observed.
Following ovulation, the corpus luteum is formed; it reaches maximum size and secretory activity at around 8 days after ovulation. Should no gestation take place, the corpus luteum becomes involuted, giving way to the formation of new follicles and consequent manifestation of oestrus. The involution of the corpus luteum is completed within 18 days of a sterile copulation (Fernández-Baca *et al.*, 1970c). If gestation starts, the corpus luteum continues its secretory activity; thereafter the female is not sexually receptive.

Sexual behaviour

Alpaca in oestrus exhibit very strange behaviour. When approached by the male the female quickly assumes the copulatory position (ventral decubitus). Since follicular activity continues even in the absence of the male, all females in a herd are sexually receptive at the same time. Consequently when mating begins there is very intense sexual activity. Copulation of alpaca occurs with the female in the ventral decubitus position and lasts from 20 to 50 minutes. Apparently, there is no relation between the duration of copulation and the rate of ovulation or fertilization. A male during the first day of mating may serve up to 12 females; on subsequent days, its activity diminishes considerably.

Fertilization and mortality of the embryo

It has been found that at least 85 percent of the females that ovulate in response to the coital stimulus have at least one ovum fertilized within three days of service (Fernández-Baca, 1970). But there is a very high mortality of embryos during the first month of gestation. Only about 50 percent of the embryos survive beyond 30 days of gestation. The reasons for this high mortality are still unknown but it is obvious that it seriously affects the annual birth rate.

Diagnosis of pregnancy

Changes in sexual receptiveness of females in relation to the secretory activity of the corpus luteum have been taken as the basis for the diagnosis of pregnancy. Once a female has been served, it ovulates, but if it does not become pregnant it invariably goes into oestrus again, starting 13 days after having been served and remaining sexually receptive until such time as it receives another stimulus that induces ovulation. Any female not in oestrus within 18 to 20 days after having been served can be considered pregnant.
The diagnosis of pregnancy based on sexual behaviour can easily be checked by rectal palpation.

Gestation and parturition

Gestation in alpaca averages 342 and 345 days in Huacaya and Suri respectively (San Martín *et al.*, 1968). The placenta is of the simple-diffuse type, microscopically corresponding to the chorial epithelium type.
Even though both ovaries are equally active in the production of follicles, it has been found that over 95 percent of pregnancies are located in the left horn of the uterus (Table 3). Transuterine migration, from the right horn of the uterus to the left, occurs frequently. This is evident from the location of the corpus luteum in the right ovary and the foetus in the left horn of the uterus. Alpaca drop their young very easily; cases of dystocia are exceptional.
The female returns to a state of oestrus within 48 hours after dropping her young, though with very little follicle growth. Follicle growth capable of responding by ovulation to coitus is observed from the fifth day; nevertheless the highest rate of fertility is obtained from 10 days after parturition (Sumar *et al.*, 1972).

Nutritional factors

The structure of the stomachs of the alpaca and other members of the Camelidae differs from that of other ruminants such as sheep and cattle. The fundamental distinction lies in the third stomach, which is not sharply differentiated. This fact accounts for the view that the Tylopoda group, to which the Camelidae belong, is completely separate and different from the ruminants.
However, it is generally accepted that the Camelidae have four stomachs (Vallenas, 1965) even though these have very special features. One such feature is the existence of oblique furrows with glandular bags in the dorsal sac of the rumen, but the role of these structures in the digestive process is unknown. Digestibility trials suggest that alpaca and llama are able to use the energy contained in forage, especially poor-grade forage, more efficiently than sheep. Recent studies on the concentration of volatile fatty acids along the gastro-intestinal tract of alpaca and llama (Vallenas *et al.*, 1973) also suggest more efficient absorption than in sheep and cattle. These observations may explain the ability of Camelidae to utilize the poor quality lignified grasses found at high elevations.

Management

The organization of stock raising as well as the technological level achieved vary considerably with the communities owning alpaca and with the system of land tenure. In the campesino communities management is generally poor: the animals are all herded together, with no separation by either sex or age, and frequently alpaca and llama are raised together, so that crosses between the two species occur.

Herds

In the associative or cooperative enterprises and among small and middle-class owners, alpaca herds are

usually better managed. The animals are classified according to type (Suri or Huacaya), colour of fibre, age and sex, and are kept in herds of 200 to 1 000 head. The percentage of females of breeding age in each herd varies from 30 to 40, while about 30 percent of the herd consists of castrated males kept for fibre production.

TABLE 1. Estimated population and distribution of South American Camelidae

	Peru	Bolivia	Chile	Argentina
Alpaca	2 887 400	300 000	20 000	Few
Llama	915 000	2 500 000	70 000	500 000 (?)
Vicuña	30 000	2 000	—	—
Guanaco	Very few	Very few	?	100 000

TABLE 2. Effect of various stimuli on ovulation rate in alpaca

Type of stimulus	Number of females	Number that ovulated	Number with eggs dividing	Number with multiple eggs
Sighting of male [1]	20	1 (5%)	0	0
A single mounting [2]	13	2 (15%)	0	0
Mounting + AI	9	3 (33%)	2	0
Interrupted service [3]	10	6 (60%)	4	1
Sterile service	22	17 (77%)	0	2
Sterile service + AI	21	18 (86%)	[4] 3	1
Single service	44	36 (82%)	30	3
Multiple service [5]	10	7 (70%)	[6] 6	0
750 IU HCG	10	10 (100%)	0	1
750 IU HCG + AI	18	18 (100%)	4	4

SOURCE: Fernández-Baca *et al.* (1970a).
[1] Without servicing. — [2] Single mounting without introduction of penis. — [3] Service interrupted five minutes after start. — [4] The ova of three animals were not recovered. — [5] Three services in 24 hours. — [6] The egg of one animal was not recovered.

TABLE 3. Relation between the location of the corpus luteum and the embryo in alpaca

Location of the corpus luteum	Number of animals observed	Animals with embryo in one horn of uterus	
		Right	Left
Right ovary	472	12	460
Left ovary	440	3	437
Both ovaries [1]	16	0	16
Total	928	15 (1.6%)	913 (98.4%)

SOURCE: Fernández-Baca *et al.* (1973).
[1] In all cases a single foetus was found in the left horn of the uterus.

Alpaca are often managed in much the same way as sheep; however, recent studies indicate the need for more appropriate management practices to suit their special characteristics.

On organized farms mating takes place during the rainy season from December to March when pasture is at its best and each male services 20 to 25 females. Recent research shows that by using two groups of males alternately, a much higher birth rate is obtained than with the traditional system of continuous mating.

ALTERNATE MATING

In alternate mating, each group of males remains with a herd of females for about 7 days, at the end of which the second group takes over, and so on. Each male therefore gets a 7-day rest between mating periods. This system, which has been applied to commercial herds, has raised the birth rate by about 50 percent (that is, up to about 80 percent). The practice is based on the observation that mating is very intense during the first 2 to 5 days when the males are placed together with the females and then declines rapidly despite the number of receptive females still in the herd. The young are born at an advanced stage of development and weaning occurs at 6-7 months of age. The female can be served again 15 days after dropping her young.

SHEARING

Shearing of the fleece is done between October and November; it is recommended that the shearing be done annually in order to obtain high-grade wool and to make the control of external pests, especially the itch mite, easier.

Alpaca depend entirely on natural grassland for feeding; the usual carrying capacity is 1.5 to 3 animals per hectare.

The alpaca's life span extends to 15 years. Starting at the age of 10, however, alpaca usually exhibit marked dental deterioration and should be culled.

Artificial insemination and egg transfer

Artificial insemination of alpaca is technically feasible (Fernández-Baca and Novoa, 1968).

The semen can be collected by means of electrical stimulation; at present semen collection using the artificial vagina in a dummy is being tried. Ovulation is induced either by the use of a vasectomized male or by the injection of chorionic gonadotropin. Practically speaking, the artificial insemination of alpaca females with vicuña semen to obtain paco-vicuñas affords economically good prospects. In trials to date, a fertility rate of around 25 percent has been achieved with AI using undiluted semen. Alpaca have certain advantages in AI over other species because of the continuous follicular activity and the consequent state of sexual receptivity.

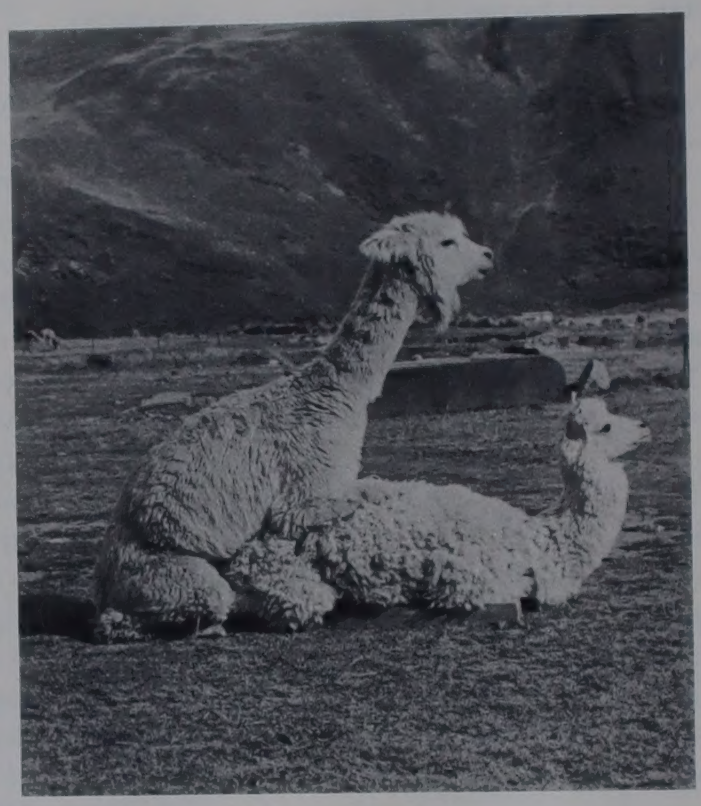
Trials conducted show the technical feasibility of transfer of fertilized eggs by laparotomy. However, for large-scale work further research is necessary.

Productivity

The fibre is the principal source of income from the raising of alpaca. However, alpaca also contribute substantially to meat production, which can be considerably increased. Another source of income, which is constantly growing, is from the skins of animals less than three months of age. The skins are used in the production of handicrafts.

The annual fibre clip per animal ranges between 1 and 4 kg, averaging 1.8 kg. There is a highly significant correlation between the weight of the fleece and body weight. At present there is a marked preference for white fibre; however, the expansion of the fur industry is creating a wider market for skins of other colours as well. Little is known about the inheritance of fleece weight or body weight in alpaca and there is no information concerning the hereditary mechanisms influencing fibre colour.

Alpaca meat resembles mutton in flavour, although the meat of adult animals has a very strong, characteristic odour. The flesh of young animals less than one year of age is delicious. At birth, the young weigh about 8 kg; this weight is doubled during the first two months of life, and then increases at a slower rate. A three-year-old male can reach a liveweight of about 75 kg and a female about 65 kg, with corresponding carcass yields of 60 and 55 percent (Calderón and Fernández-Baca, 1972).



Semen collection, using the dummy of a female alpaca

On commercial ranches serious problems arise from the low birth rate and high mortality among the herds. Little culling is practised, the only reason for any at all being old age. Such culling as is adopted on well-organized ranches does not exceed 8 percent.

The fur industry is now confined to the use of skins of animals that die before the age of three years. The advisability of early slaughter of males that are not to be used as sires is currently under consideration to facilitate the better use of hides and meat.

The udder of the alpaca consists of four glands, each with its own teat. Although it is possible to milk alpaca, this is not normal practice.

The alpaca is not used as a beast of burden; the only species used for this purpose is the llama.

A question frequently asked is whether sheep or alpaca are more efficient from the standpoint of productivity. Without doubt alpaca surpass sheep in their capacity to use rangeland at over 4 000 m above sea level. On lowlands there is no experimental evidence demonstrating the productive superiority of one or the other species.

The main factors influencing production in the Andes are nutrition, low birth rate and disease.

NUTRITION

Alpaca are raised entirely on the ranges of the Andean highlands (altiplano). Their productivity therefore depends on the quantity and quality of the nutrients which are provided by these grasslands and which fluctuate with the season. On the Andean highlands where alpaca are raised there are two marked seasons: the rainy season, from December to March, and the dry season, from April to November. Annual precipitation ranges from 900 to 1 200 mm; over 90 percent of this rainfall occurs during the rainy season. Ample forage is available during the rainy season, the opposite being true during the dry season. From all indications, failure to ovulate and mortality of embryos are associated with scarcity of forage. Recent work indicates that it is possible to increase considerably the carrying capacity of the Andean rangeland by the introduction of improved forage and fodder species. By an association of ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*), irrigation, and the application of nitrogen fertilizers, up to 30 adult alpaca can be carried per hectare per year as compared with the usual rate of 1 to 1.5 alpaca per hectare on natural grasslands. Despite the altitude and low night temperature it

has been found possible to ensure sustained yields of such plant associations all year at elevations up to 4 200 m above sea level.

In campesino communities where each person owns his own animals and no one owns the land, the shortage of feed is aggravated by the improper management (overgrazing) of natural grasslands.

Low birth rate

It is estimated that at present no more than half of the female alpaca of reproductive age produce young every year. Apart from the economic losses resulting from this low reproductive rate, there is also a serious handicap in that it reduces the intensity of selection that can be practised for traits of economic importance. As pointed out earlier, the problem does not lie in fertilization failure but rather in survival of the embryos, about 50 percent of which die during the first month of gestation. The reasons for this high embryo mortality are still unknown but the fact that over 95 percent of gestations that are brought to term are located in the left uterine horn (Table 3), even though ovulation of both ovaries is equivalent, suggests the existence of some endogenous factor that determines the differential survival of the embryos. Apparently only those embryos survive that originate in the left ovary, unless those of the right ovary migrate to the left horn of the uterus. The role of other factors such as nutrition, diseases or genetics on embryonic mortality in alpaca is as yet unknown.

Failure of ovulation may also be an important factor in low birth rates in the alpaca. Proper management of these animals during mating, which offers opportunities for new service (e.g., by alternate mating) to females that have not ovulated or have prematurely lost their embryos, has made possible an increase in the annual birth rate on some ranches to 80 percent (Novoa *et al.*, 1973).

Diseases

Health problems have serious repercussions on the raising of alpaca due to the decrease in productivity and high mortality. Moro and Guerrero (1971) have described the main infectious diseases and pests and have pointed out that alpaca are susceptible to most of the infectious diseases of other ruminants. But they are particularly sensitive to some of them and relatively resistant to others. Thus, the young are very susceptible to the enterotoxaemia caused by *Clostridium perfringens (welchii)*, types A and C. In some years mortality due to this causal agent can amount to 50 percent, depending on local conditions. Among adult animals, the so-called *fiebre de los alpacas* (alpaca fever) caused by *Streptococcus pyogenes* leads to high mortality on some ranches. Stomatitis caused by *Sphaerophorus necrophorus* and osteomyelitis of the mandible caused by *Actinomyces* spp. are two diseases which, even though they do not cause high mortality, notably affect productivity. Other diseases in alpaca that have been diagnosed are brucellosis (caused by *Brucella melitensis*), listeriosis, keratitis, otitis, rabies and mastitis.

Alpaca are relatively resistant to foot-and-mouth disease. Despite many outbreaks of this disease among other species in areas adjacent to those where alpaca are raised, only a single outbreak was reported in alpaca (Moro and Guerrero, 1971).

Both endo- and ectoparasites cause considerable losses among alpaca. Among the endoparasites the group of nematodes that cause verminous gastro-enteritis is the worst. The highest incidence of *Graphinema aucheniae, Nematodirus lamae* and *Lamanema chavezi* occurs in alpaca. The first produces small nodules and

Spraying to control and treat ectoparasites

congestion of the mucous membrane of the abomasum, while the others are haematophagous parasites. *Lamanema* also exhibits the peculiarity of hepatic migration, causing damage to the liver. Other parasitic infestations affecting alpaca are hepatic distomatosis, taeniosis, hydatidosis, cysticercosis and verminous bronchitis. Coccidiosis, produced by species of the *Eimeria* genus, *E. lamae, E. macusanensis, E. alpacae* and *E. puncensis,* the first two being the most pathogenic, is also common among alpaca. When it becomes localized in the mucous membrane of the small intestine, and under certain predisposing circumstances, it may cause serious damage.

Sarcocystis aucheniae occurs in the muscles of alpaca, some of the cysts measuring up to 1.5 cm. Recent research (Guerrero, 1974, personal communication) indicates that the transmission of the disease is through the faeces of dogs and, probably, man. Although *Sarcocystis* does not produce clear signs of infection, the commercial value of the meat of infected animals decreases considerably. In some herds, more than 50 percent of alpaca over two years of age have been found to be affected with *Sarcocystis.*

External parasites cause considerable losses due to the damage to the fibre. The most common one is the scab mite, *Sarcoptes scabiei*, var. *aucheniae.* The mites may be found in the skin which is not covered by hairs, and may in serious cases spread all over the body and produce many lesions. The itch, caused by the common itch mite *Psoroptes communis* var. *aucheniae*, is localized around the ears and neck.

Conclusions

The importance of South American Camelidae in general, and of alpaca in particular, to the economy of the inhabitants of the Andean altiplano is beyond question. Improvements in alpaca raising and greater economic returns can be achieved through in-depth research on the biology and pathology of this species and through application of the knowledge thus gained by dissemination of the findings among alpaca raisers.

Alpaca have certain characteristics that are markedly different from those of other ruminants; it is therefore not possible to adapt animal husbandry techniques developed for other species without running the risk of seriously compromising the alpaca's productivity. Some of the features discussed in this article underline this observation. It is therefore necessary to develop, through research, techniques for alpaca raising compatible with the characteristics of this species and the geographical areas in which it can be raised. The dissemination of new techniques and their application by alpaca raisers present major problems when one considers the social structure and educational level of the mass of campesinos who own the bulk of the alpaca population in both Peru and Bolivia. The incorporation of campesino communities in new associations or cooperatives through land reform in Peru is regarded as one possible way of introducing changes in their stock-raising technology.

Government attention to such vital aspects as the marketing of alpaca fibre and meat and the granting of credit to alpaca raisers will play a decisive role in the improvement of their production.

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International collection and dissemination of information on animal feeds

by Lorin E. Harris and Leonard C. Kearl

The need for full information on animal feeds is well recognized. It may serve for agricultural planning or for trading purposes, but is of particular importance in ration formulation. The cost of feed is of great importance in the economics of animal production. The increasing scarcity of the world's food supply calls for greater precision in its use as feed for farm animals, but this presupposes that the productive value of feeds as well as the nutritional requirements of animals is accurately and widely known. Such knowledge, obtainable only through research, needs to be converted through documentation into meaningful information that is accessible to all potential users.

There is therefore a great need for data collection to be closely linked to research and to be organized on an international level. This article is concerned with an attempt to establish through international cooperation a world data bank on the nutritive value and use of feedstuffs.

Background

In countries with a high standard of animal production the composition of feedstuffs and their nutritive value for animals of various kinds and levels of production are fairly well documented. Information is also available on alternative ways of using the materials in rations. However, improved facilities for rapid retrieval and for international exchange of such information would greatly enhance its value.

In most of the developing world there is not only a serious lack of statistics on available materials but also a major deficiency in essential basic data on chemical, physical and biological constants for feeds. Unfortunately, little of the information needed on the nutritional characteristics of a developing country's existing or potential feed supply can be derived from established feed data from the technically advanced countries. The problems faced by the animal nutritionist in developing countries (which represent, roughly, the tropical world) are very different indeed from those encountered in the more highly developed temperate zones. The demand situation for human food does not usually allow the feeding of products which are suitable for human consumption to animals. Forages and crop by-products from the agro-industrial sector therefore form the major source of feed. Not only do the different plant species account for a large part of the variation in chemical and physical plant properties, but the stage of maturity and the environmental effects of climate, soil and fertilization also influence these characteristics. High temperatures and intense solar radiation, for instance, have an accelerating influence on the lignification process, which, in turn, is an important factor affecting digestibility.

Food technology for the preparation of human foods with by-products suitable for animal feeding is still very much at an unsophisticated level of development. Feed production continues to be integrated into the animal production sector, and work to be undertaken in animal nutrition has to be closely oriented to the conditions prevailing in a given region or even in a specific location. This, added to the profound information gap in developing countries, points to the urgent necessity for generating data through applied nutrition research, preferably on the spot. National and international development aid organizations have a responsibility to provide guidance in the planning and conduct of such work to ensure documentation of the information generated.

Ideally, systems applied in handling feed data should be compatible with the efficient exchange of such data between centres. Specialized information centres in some technically advanced countries have been working toward such compatibility and toward the creation of a common data base with the possibility of rapid, computerized retrieval. It seems sensible therefore to suggest that the data emerging from research in de-

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veloping countries be added to the common data base and that in future due consideration be given to universal requirements in international standardization efforts at data processing.

form processing, was required. In 1971 FAO appointed a consultant to review on-going international activities in the fields of feed data collection and retrieval and to report on possibilities for international collaboration. The report considered the value of a collaborative effort in this field both to developing countries and to animal production at the international level and recommended that FAO act as coordinator for international activities in this field.

Above: Conducting an in vivo *digestibility and balance trial. Right: Determining* in vitro *digestibilities of feedstuffs.*

International network of feed information centres

The need for information on nutritional value of feeds over vast geographical areas was highlighted when FAO commenced work on the Indicative World Plan in the mid-1960s. This need was therefore followed up by FAO's Statistical Advisory Committee of Experts, but attempts to collect data using questionnaires proved unsuccessful. It thus came to be realized that the problems of data accumulation from the developing countries could not be solved by assembling material supplied on request, but that technical advice on generating data, followed by coordinated systematic collection and uni-

A first consultation meeting was held in 1971 in Rome. At that time representatives from several feed information services formed the International Network of Feed Information Centres (INFIC). Members (besides FAO) were: the Australian Animal Feedstuffs Collating Centre, Canberra; the Canadian Department of Agriculture, Ottawa; the Documentation Centre at the University of Stuttgart-Hohenheim, Federal Republic of Germany; the International Feedstuffs Institute of the Utah State University; and the USAID Feed Composition Project, Florida. Since then this group has met once a year and has been joined by representatives from the International Livestock Centre for Africa (ILCA), Addis Ababa; l'Institut d'élevage et de médécine vétérinaire des pays tropicaux (IEMVT), Maisons-Alfort, France; and the Tropical Products Institute (TPI), London, United Kingdom. The USAID Feed Composition Project in Florida has meanwhile been terminated and its remaining activities transferred to the Utah Centre. Participation by other feed information services continues to be welcomed by INFIC; thus, it is considered desirable to have a Latin American Centre cooperating with Utah. The regular annual meetings of the group have been concerned with policy matters and with planning and development of the international network.

The aim of INFIC is to combine, by use of the computer, world data on the composition and nutritive value of materials which are or may be used as feeds and to provide linked abstracts of and references to other information about feeds. This necessitates interconversion of existing data stocks and adoption of standardized

methods of data collection and processing. For the establishment of such a common data base, work toward a number of subordinate goals has been identified.

I. GEOGRAPHICAL COVERAGE

This requires that different centres be responsible for the acquisition and processing of data from different regions of the world. At present only the centres at Hohenheim and Utah are able to undertake computerized handling. However, the Institutes in Canberra and Maisons-Alfort plan to reach this stage shortly. It is therefore planned that, for the time being, data collected by institutions without computer facilities will be sent to one of the two fully equipped centres. The complete correlation of master tapes will, however, be undertaken by a single centre only; at present this is Utah. The distribution of geographic responsibility is as follows:

(*a*) Africa: Hohenheim, in cooperation with FAO, ILCA, IEMVT and TPI;
(*b*) Europe: Hohenheim;
(*c*) Latin America: Utah;
(*d*) Near East: Utah, in cooperation with FAO and TPI;
(*e*) North America: Utah and Ottawa;
(*f*) Oceania and southeast Asia: Canberra and Utah.

Published feed data and information are collected from world literature.

II. ADVICE ON FEED EVALUATION METHODS

A body such as INFIC, which encourages the production of feed data and undertakes their collection, has a responsibility to advise analysts on the most suitable and useful analytical determinations. There is a particular need to recommend economical determinations that most accurately reflect the energy value of feeds. International agreement on the use of energy systems for expressing energy values is also urgently needed. The results of discussions between leading analysts and workers in energy metabolism and other related fields will therefore be put into effect.

III. DATA RECORDING

The direct transfer of data to an electronic computer system requires a unified method for the recording of laboratory analytical data as well as of published information.

Agreement has therefore been reached within INFIC for establishing an international recording system. The code numbers used on the international source form — which was developed by Harris (1963), and which already has wide distribution — are to be retained in any future recording system. An enlarged recording system has already been proposed by Hohenheim and a data input sheet in French, based on the Utah source form, is under preparation at Maisons-Alfort. For the incorporation of literature and summary abstracts (which are available in certain centres) it is planned to insert into the abstracts an International Abstract Number and an International Feed Reference Number.

Punching data from the source forms into cards. The data are transferred from these cards into the computer, and stored on disks or tapes.

IV. VOCABULARY AND PRINCIPLES FOR DESCRIBING FEEDS

In recording data from different parts of the world and processing them for use in a common data bank, a standardized unambiguous identification system for feedstuffs is essential. This must include (*a*) a vocabulary consisting of elements (descriptors) that do not overlap, and (*b*) regulations for the use of these descriptors in naming feeds. Based on the principles of the *International feed nomenclature* (Harris *et al.*, 1968a) developed at the Utah Centre in cooperation with Canada and used in Australia, Latin America and North America, a new vocabulary in English, French and German was recently proposed by the Hohenheim Centre. After review by a specialized committee, this has been adopted by INFIC. The vocabulary is divided into logical categories (or facets) as explained below. A feed name is established by combining descriptors of different facets, and a translation by computer is possible — for example, from English into French names. The terms used in the vocabulary might not always correspond to those in common use in a given country. In these instances adjustments will have to be made for

conversion of international documentation terms into common terms.

V. Agreement on coding and computer programming

To achieve exchange by computer of data in the data banks at Hohenheim and Utah, in addition to nomenclature, prior agreement is also necessary on information code numbers, feed classes, data structure and appropriate computer programmes. Work is in progress for the establishment of an International Data Processing System, by integrating the best parts of both systems at present in use at Utah and Hohenheim.

The authors (left, L.C. Kearl, right, L.E. Harris) demonstrate least-cost ration formulation, using a remote terminal connected by telephone to the central computer at Utah State University. The operator types in the costs of the feeds, and the codes which inform the computer of animal nutrient requirements. The central computer calculates the animal diet, and the portable terminal prints out the one it will be most profitable to use.

Documentation methods employed

There is variation in the extent to which the individual INFIC centres are involved in literature documentation, that is, in the indexing of publications and preparation of abstracts from selected information. An internationally standardized form suitable for computerized handling of such abstracts is in preparation. With regard to documentation of values from feed analyses, different methods have been applied in the acquisition of data as well as in the subsequent steps of processing. However, the work toward integration of the two systems used at Utah and Hohenheim will lead to a unification of methodology. Some important steps in handling the input are outlined below.

Data come primarily from two sources: (*a*) they are requested from cooperating feed analysis laboratories on distributed recording sheets (international source forms mentioned under III above); or (*b*) they are extracted from a wide range of published and unpublished documents and are also recorded on the source forms.

All analyses on any given feed sample are entered on the same form, which is designed to gather all necessary details on the sample. The main categories of information are: laboratory address, description of the sample, experimental conditions, analytical data, including procedure reference.

Data are checked for usefulness and, if necessary, converted into standardized units or into the preferred basis. In the future a statistical analysis procedure is to be applied for deciding on extreme values.

Identification of feeds

As mentioned under IV above, a feed is named by combining elements of various facets. These are:

(1) Original material (plant, animal or other); if possible the following names are given: (*a*) scientific name including genus, species, sub-species, variety or kind, and (*b*) common name;
(2) Specific part of original material (leaves, husks, etc.): a standardized list of descriptors has been prepared in English, French and German;
(3) Process(es) and statement(s) to which the specific part of the material has been adjusted prior to being fed to the animal: a descriptor list is available as for (2);
(4) Stage of maturity (applicable primarily to forages): a descriptor list is available as for (2);
(5) Cutting or crop (applicable primarily to forages);
(6) Grade (quality designations and guarantees): true international standardization does not appear to be feasible.

Feeds have been assigned to eight classes. Further subdivision of up to nine groups each is envisaged. The eight main classes are:

1. Dry forages and roughages.
2. Pasture, range plants and forages fed green.
3. Silages.
4. Energy feeds: products with less than 20 percent protein and less than 18 percent crude fibre.
5. Protein supplements: products which contain 20 percent or more protein.

6. Mineral supplements.
7. Vitamin supplements.
8. Additives: antibiotics, colouring material, flavouring, hormones, medicaments.

Since the descriptive feed names are not quite practicable for data processing, a consecutive order 5-digit identification number (International Feed Reference number) is assigned to each name. The code for the feed class is inserted in front of this reference number (which would be a 1-digit number, making a 6-digit number in all — see table below).
Two examples of naming are given in the table. Thus the International Names for the two feeds are:

No. 1: Zea mays indentata, maize, aerial part, ensiled, dough stage (3).

No. 2: Gossypium spp., cotton, seeds w some hulls w lint, solv extd grnd, mn 36 percent protein (5).

All feed names are listed in the International Name File. Any new name not previously composed is added to this file.
Codes are assigned to all data on the source form, before they are put on punch cards. From the cards data are then transferred to a magnetic tape for sorting by data type, checking for coding errors and possible elimination of data. A number of computer programmes are available for further data processing.

Expected benefits

Benefits from the work of INFIC may be obtained by the results of international standardization of feed data documentation, and in the main from the output facilities of the common data base. The information stored in the combined data bank of INFIC will be of particular value to those involved in, for instance, research and education, planning and development, the feed industry and practical animal production. Eventually the total output is aimed at providing ready access to:

(*a*) all relevant values for chemical, physical and biological constants of existing and potential feedstuffs;
(*b*) information on relevant factors affecting the nutritional value of feeds (e.g., age of plant, soil, fertilization, temperature, method of processing);
(*c*) information relevant to the incorporation of feeds into rations (e.g., physiological restrictions by the animal, intake, efficiency of utiliz, toxicity levels).

Information retrieval may be accomplished in various ways depending on the user's needs and the facilities he has for receiving the information. Retrieval would be largely in the form of feed tables and print-outs when use of computer data and information tapes, direct or via a remote terminal, is impracticable for a user. Feed composition tables may be of the conventional form: by animal species and type of production, and by type of data (e.g., minerals, amino acids and so on). It is envisaged that in future there will be more frequent withdrawals in response to specific inquiries. The system is ideal for providing information such as the value of feeds from one crop species, from a group of crops or from the crops of a given area. Additionally, abstracts of information relevant to specific questions can be selectively withdrawn.
The system also permits analysis of factors affecting composition and nutritional value of feeds (e.g., environment and technology of processing), provided the sample analysed has been sufficiently described (for example, as requested on the International Source Form distributed to the cooperating laboratories).
Data may also be suitable for the establishment of regression equations. The importance of giving consideration to the experimental conditions under which data were obtained and of distinguishing between actually determined and derived values is well recognized. Especially important is the efficient use that can be made of the international data store by connecting with it linear programming operations for the formulation of least cost rations.

Name components	Feed. No. 1	Feed. No. 2
Genus (of original material)	Zea	Gossypium
Species	mays	spp.
Variety or kind	indentata	...
Common name	maize	cotton
Part eaten	aerial part	seeds w some hulls w lint
Process(es) and treatment(s) (to which product has been subjected)	ensiled	solv extd grnd
Stage of maturity	dough stage	...
Cutting or crop	...	...
Grade (or quality designation)	...	mn 36 percent protein
Class	(3)	(5)
International Feed Reference No.	3-02-912	5-01-632

Cooperation required to support INFIC's objectives

It is obvious that the potential output from a data bank depends both in quantity and quality on its input. The provision of information across fields of specialization, countries and languages requires close cooperation between institutions all over the world. Certainly, there are a number of limitations to achieving the aim of an optimal coverage in the documentation of world data. Particular assistance is sought by INFIC from:

1. donors for the work toward integration of the existing data stores and for international standardization in organizing future data input into a common data base;

2. feed analyses laboratories and collecting organizations, in particular those serving developing countries, in making their results available to the central data bank;
3. leading workers in the field of feed analyses and energy metabolism to make recommendations on the most economic determinations to employ and appropriate systems to choose in expressing energy values.

Representatives from the participating countries have expressed interest in the work of INFIC and pledged continued support for it. The United States Agency for International Development (USAID) has made an essential contribution through its Florida project, during which 69 laboratories in 23 Latin American countries have cooperated in producing, collecting and forwarding analysis results to the Project Centre. Comprehensive feed composition tables have been published in Spanish, Portuguese and English. Assistance by USAID is being continued for the participation of the Utah Centre in INFIC. The Government of the Federal Republic of Germany is supporting work toward INFIC's objectives undertaken by the Hohenheim Centre in cooperation with FAO and ILCA.

of materials which are or may be used as feeds, and to provide linked abstracts of, and reference to, other information about feeds. As an essential prerequisite for the successful exchange between existing data stores and for organizing future input to a common data base, agreement is being established on a multilingual feed nomenclature, on information coding, data structure and computer programming. Efforts are being made to encourage standardized data production in, and coordinated collection from, areas that are at present least well covered.

The output of the common data base may take many forms depending on the needs of users which can range from conventional feed composition tables to replies to specific inquiries. The output of the system is also immediately applicable in linear programming operations for the formulation of least cost rations.

INFIC can provide a unique service to advisers in developing countries; it also incorporates services of proven value for the technically advanced countries.

To become fully successful in its work INFIC requires the collaboration of all laboratories that produce or hold information on feeds, particularly in developing countries, and continued support from funding agencies.

Summary

The aim of INFIC is to combine (by the use of the computer) world data on the composition and nutritive value

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in the next issue

The place of livestock in small farm development
Crossbreeding for milk production in Sri Lanka
Economic problems of milk schemes in developing countries
The development of the Jamaica Hope breed of dairy cattle
Minimum concentrate feeding for efficient milk production
New trends in ensiling forages

EXPORTING ANIMALS AND MEAT FROM DEVELOPING COUNTRIES

the major impediments

The export of meat and animals from developing to developed countries is impeded by many factors ... notably those concerned with hygiene

by S. Kafel

The potential for increased animal and meat production for export exists in a number of developing countries. This potential, in terms of animal units per one million human population, is illustrated in Table 1 for selected developing countries and is compared with the situation in one European country (Poland). However, the export of meat and animals from developing to developed countries is impeded by many factors, notable among which are barriers of a sanitary nature. These are created

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TABLE 1. Number of animal units[1] for every million of human population, in selected countries

Country	Animal units
Botswana	3 245 000
Chad	1 348 000
Ethiopia	1 149 000
Kenya	938 000
Madagascar	1 368 000
Mali	1 291 000
Niger	1 414 000
Somalia	2 247 000
Sudan	1 200 000
Tanzania	1 010 000
Uganda	545 000
Argentina	2 392 000
Brazil	1 207 000
Bolivia	700 000
Chile	419 000
Colombia	1 002 000
Paraguay	3 062 000
Uruguay	3 459 000
Venezuela	829 000
Mexico	554 000
Poland	**479 000**

SOURCE: Based on data in the FAO/WHO/OIE Animal Health Yearbook, 1973.
[1] One animal unit = 1 ox = 1 camel = 1 buffalo = 4 pigs = 12 sheep or goats.

mainly by the animal disease situation, the low standard of meat hygiene and meat inspection and overall inadequacies in the veterinary services.

Animal health requirements

According to the terms of bilateral veterinary conventions and agreements contracted during the last few decades, many countries require the contracting partner country or part of the country to be free from specific infectious diseases for a determined period of time, if animals or meat are to be imported from that country. In some cases, the disease-free period stipulated for a defined territory is 12 months or more. Such stipulations may also be found in the European Economic Community Council Directive (1972) on veterinary and public health requirements for importation of cattle, pigs and fresh meat from third countries. Among the diseases enumerated in the veterinary conventions, regulations of the EEC and of other countries, foot-and-mouth disease and rinderpest pose the greatest difficulties for developing countries. The EEC Directive also requires, among other conditions, that meat originating from animals showing any form of tuberculosis or positive reaction to the tuberculin test, and from animals carrying one or more live or dead cysticerci shall not be exported to the EEC countries.

United States regulations (1971) stipulate that an application for a permit to import animals will be deied for domestic ruminants or swine from any country where it has been declared that foot-and-mouth disease or rinderpest exists. Application for import may also be denied because of: communicable disease conditions in the area or country of origin, or in a country where the shipment has been or will be held or through which the shipment has been or will be transported; deficiencies in the regulatory programme for the control or eradication of animal diseases; in-

TABLE 2. Animal disease situation in selected African and Latin American countries

Country	Foot-and-mouth disease	Rinderpest	Contagious bovine pleuro-pneumonia	Sheep pox	Blue tongue	Swine fever	African swine fever	Cysti-cercosis (bovis)	Cysti-cercosis (cellulosae)
Botswana	—	—	—	—	?	—	(—)	++	?
Chad	++	Much reduced	+++	+	(—)	(—)	(—)	++	Recently recog.
Ethiopia	+++	Much reduced	Some regions	+++	?	—	+	+++	(—)
Kenya	+++	(—)	+	+	+	—	—	++	—
Madagascar	—	—	—	—	—	++	—	(—)	+
Mali	Recently recog.	++	+++	Incidence unknown	...	—	(—)	++	++
Niger	+++	Some regions	Some regions	+	(—)	—	—	++	++
Somalia	+	+	++	?	—	—	—	+	—
Sudan	+	Much reduced	+	+	(—)	—	—	Some regions	—
Tanzania	+	—	—	—	—	—	—	+	—
Uganda	++	(—)	Much reduced	(—)	(—)	(—)	(—)	++	(—)
Argentina	Some regions	—	—	—	—	Some regions	—	+++	++
Brazil	++	—	—	—	—	++	—	+	++
Bolivia	+++	—	...	—	(—)	+++	—	++	+++
Colombia	++	—		—	—	++	—	(+)	++
Paraguay	++	—	(—)	(—)	—	++	—	++	++
Uruguay	++	—	—	—	—	++	—	+	+
Venezuela	++	—	—	—	—	++	—	+	+
Mexico	—	—	—		(—)	+++	—	++	++

SOURCE: Based on data in the FAO/WHO/OIE Animal Health Yearbook, 1973.
KEY: — Not recorded, obviously not present (—) Not recorded, probably not present. ? Suspected. ... No information available. + Low sporadic incidence. ++ Moderate incidence. +++ High incidence.

adequate veterinary services in the countries concerned; the importer's failure to provide satisfactory evidence concerning the origin, history, and health status of the animals; lack of satisfactory information necessary to determine that the importation will not be likely to transmit any communicable disease to livestock or poultry in the United States; or any other circumstances which it is believed require such denial to prevent the dissemination of any communicable disease of livestock or poultry in the United States.

Data reflecting the animal disease status in selected African and Latin American countries are shown in Table 2. They show the seriousness of the situation confronting these countries and the difficulties to be overcome before the export of animals or meat could legally be practised on a larger scale.

TABLE 3. Veterinarians and veterinary education in some African and Latin American countries

Country	Veterinarians	Vets employed in meat inspection [1]	Meat inspectors	Veterinary faculties	Intermediate vet. schools	Vet. students at home and abroad	Number of veterinarians per million animal units
Botswana	17	1	10			4	11.0
Chad	10	1 (2)	3			13	1.7
Ethiopia	36	10 (1)	40		2	40	1.2
Kenya	155	7 (1)	54	1	1	111	19.2
Madagascar	44	(12)	110			20	3.3
Mali	38						5.5
Niger	13						2.3
Somalia	32	4 (7)	66		1	25	4.7
Sudan	205	9		1		383	10.7
Tanzania	78						5.5
Uganda	49						10.4
Argentina	2 000	535	1 500	5			36.0
Brazil	4 000	170		15	1		34.0
Bolivia	80	10 (7)	2			150	22.0
Chile	171			2			42.0
Colombia	1 011	12	35	5		1 546	41.0
Paraguay	300	17 (10)	53	1		200	50.0
Uruguay	248	54	144	1			23.0
Venezuela	129	(25)	85	3	1		14.0
Mexico	3 800	32	500	9		2 200	129.0
Poland							**229.0**

SOURCE: Based on replies to a questionnaire sent by FAO to selected countries in 1972.
[1] Figures in brackets refer to veterinarians employed part time in meat inspection.

Meat hygiene and inspection

The EEC Directive concerning animal health and veterinary inspection as applied to the importation of fresh meat from third countries requires a high standard of hygiene in slaughterhouses, cutting plants, cold stores, packing plants and in the means of meat transportation. Special attention is also paid in this Directive to hygiene of equipment and personnel and to the proper exercise of ante-mortem and post-mortem inspection. U.S. regulations require that the system of meat inspection maintained by any foreign country, with respect to establishments preparing products for export to the United States, should ensure compliance of such establishments and their products with requirements at least equal to all the inspection and building construction standards and to all other provisions which are applied to official establishments in the United States. Most developing countries cannot meet these requirements. Their shortage of facilities for animal slaughter, meat cutting, processing, packing, storage, transportation and laboratory examination, and low standards of meat hygiene and meat inspection, thus present important impediments to international meat trade.

However, some developing countries, notably in Latin America, possess an established meat export tradition. There are others that have a few export slaughterhouses, but due to inadequate standards of hygiene or lack of facilities are unable to sell their meat to the developed countries.

Structure and powers of the veterinary services

A basic condition in all negotiations for multilateral veterinary agreements conducted during the last two decades is that the participating countries should have an efficient veterinary service. Analysis of bilateral veterinary conventions shows that these were also based on the assumption and recognition that both contracting parties possess an efficient veterinary service capable of effectively implementing the clauses of the conventions, particularly ascertaining the facts and providing the necessary sanitary guarantees.

Article 3 of the EEC Directive states that in deciding whether a country or part of a country may appear on the list of exporters to the Community, particular account shall, among others, be taken of:

— the structure and powers of the veterinary services;

— the regularity and rapidity of the information supplied by the third country relating to the existence of contagious animal diseases;
— the organization and implementation of measures to prevent and control contagious diseases.

Reporting and control activities undoubtedly depend to a great extent on the structure and powers of the veterinary services and on the number of veterinarians in a particular country. For the execution of veterinary practices to meet the export-import requirements imposed at present by developed countries, the veterinary services in an exporting country should possess an adequate structure and the executive powers to inspect effectively:

— premises and pastures where animals are reared or detained;
— migrating herds;
— transport of animals and their products including means of transportation and loading facilities;
— gatherings of animals, particularly livestock markets;
— animal dealers and related facilities;
— slaughterhouses and other meat establishments;
— tanneries and rendering plants;
— commercial and industrial establishments for animal feed;
— veterinary pharmacies, commercial and industrial establishments for products destined for the diagnosis, prevention or treatment of animal diseases;
— veterinary clinics.

In some countries, however, and especially in Africa, the number of veterinarians is not much greater than the number of veterinary duties enumerated above; and some of the veterinary professionals in these countries occupy positions in offices or in institutions unconnected with veterinary services. In such a situation, it is virtually impossible to perform the functions necessary for maintaining a satisfactory disease situation and good meat hygiene standards in the whole country. This state of affairs may prove extremely difficult to overcome in countries where there is a lack of veterinary schools, inadequate funds to hire veterinarians, lack of resources for the production or purchase of vaccines, lack of up-to-date laws and regulations and sometimes misunderstandings among policy and decision-makers in solving the problems of animal disease and meat hygiene. Some data reflecting current manpower availability and education in the animal health sector in selected African and Latin American countries are set out in Table 3.

Very poor sanitary conditions in an open air meat market.

Some solutions

The complete eradication of contagious animal diseases presents difficulties not only in the developing countries but also in countries having a large number of veterinarians and relatively good financial support for disease eradication campaigns. It would therefore seem desirable to create isolated areas or specific disease-free zones in particular countries where total eradication of these diseases is not immediately feasible. The major considerations governing the creation of specific disease-free zones were discussed in a previous issue of *World Animal Review* (Griffiths, 1972). Some technical questions relating to such zones have also been covered in the *Manual on standards of veterinary services, meat hygiene and meat inspection, post-mortem judgement of meat, and establishment of disease-free zones* (FAO, 1974). This manual also suggests sanitary standards in meat establishments that should be met by countries having a meat export potential so as to facilitate international trade in meat. Another publication relating to the organization of meat inspection services at a country and meat establishment level and manpower requirements for these services is currently being planned.
A tabulated summary of animal health requirements based on an analysis of recent veterinary conventions and agreements was presented in the FAO publication *Non-tariff barriers to international meat trade arising from health requirements* (FAO, 1973). However, it is realized that there are many meat hygiene and meat inspection rules and practical requirements which are not specified in laws or regulations but evidently applied in practice. Furthermore, some of the existing regulations are difficult to interpret. It has therefore

Acceptable standards of hygiene in a meat cutting plant.

become common practice for veterinary meat inspectors from importing countries to pay visits to meat plants in exporting countries that produce goods for export and during such visits they check on the practical sanitary control measures being undertaken and specify the particular meat hygiene requirements that should be met.

Practical training in meat hygiene and meat inspection is indispensable to those developing countries that have a meat export potential but lack a long tradition in this field. Such training could be carried out in a recognized meat exporting country having a developed meat industry, strong meat inspection services, a good standard of meat hygiene, updated meat inspection regulations and a good reputation in exporting meat products. Among the FAO activities in this field is a practical course (planned for 1976) for English-speaking African countries on the sanitary requirements of meat importing countries.

The ability of a country to meet the standards and to fulfil the sanitary requirements for meat exports depends to a great extent on an adequate number of professional personnel. Due attention should therefore be paid, and all possible action taken to increase the number of properly trained veterinarians and meat inspectors. Data recently collected by FAO from 32 selected countries showed that the number of hours devoted to the teaching of meat hygiene or food hygiene in veterinary faculties range from 8 to 560. To overcome this great disparity, FAO is currently elaborating an organizational scheme for meat hygiene departments within the framework of veterinary faculties and is planning suitable training curricula in the subject. Additionally, in order to increase the effectiveness of teaching and to harmonize training curricula, a Meat Hygiene Training Kit containing about 5 000 colour pictures, with their descriptions recorded on tape, is under preparation. Due attention is paid to illustrating the sanitary requirements of the main meat importing countries.

An analysis of present meat inspection training curricula at intermediate level schools in various countries also showed great divergence in the approach to the subject, both in the number of hours devoted to it and in the level of training. FAO has therefore initiated work on a standard curriculum for these schools and it is expected that the training kit will be a useful tool in the realization of this programme.

Since 1966 two courses for lay meat inspectors, organized jointly by FAO and WHO, have been held annually in Kenya for trainees from the English-speaking countries in Africa, with about 20 candidates enrolled in each course. The funds for the Training Centre have been made available by the Danish Government. Similar courses on a regional or national basis are also needed in other developing regions or countries.

Conclusion

Eliminating sanitary barriers to international meat trade will depend to a great extent on policy trends and on the financial means available to the potential meat exporting countries themselves. Eradication of contagious animal diseases and bringing meat hygiene and inspection to a required standard will certainly bring national benefits and will facilitate meat exports. However, to attain this goal in developing countries in a relatively short time, still more effort and investment are needed from the countries themselves and more scientific and technical assistance from international organizations.

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Hides, skins and animal by-products —

by S.K. Barat

An average cattle hide constitutes 7-7.5 percent of the animal's liveweight and a typical sheepskin 10-12 percent. Normally, hides represent 5-10 percent and skins about 25 percent of the total value of the animal. Other inedible by-products include intestines, gut contents, blood, bones, horns, hooves, internal fat, wool, hair and bristle, all of which represent valuable raw materials.

Slaughterhouse offals are often thrown to vultures

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The leather industry embraces three distinct but interdependent stages. The first is the production of hides and skins which are mainly derived as by-products of livestock raised for other purposes. The second involves the tanning and finishing of hides and skins into various types of leather with properties suitable for the respective end uses. This processing of the raw material into leather, an intermediate product, is carried out in tanneries which exist in widely varying degrees of sophistication in terms of technology, machinery and equipment, as well as scale of operation. The third stage is the manufacture of leather into consumer articles of various kinds such as footwear, garments, belts, travel goods, bags, purses and wallets. About 60-70 percent of the total output of leather is utilized for the making of shoes, about 20 percent for garments and the rest for other articles.

In most of the primary producing countries of the third world, however, the full potentialities for the development of hides, skins and animal by-product resources are yet to be realistically worked out. It is not uncommon to find a typical country in the third world wasting valuable slaughterhouse blood and at the same time importing blood meal; exporting crude bones at a nominal price while importing expensive cattle licks and rock phosphates; throwing slaughterhouse offals to jackals and vultures and at the same time continuing to import protein concentrates and other compound feeds; selling hides and skins in the raw, and repurchasing them from abroad as finished leather and leather products. Even hides and skins of considerable potential value fail to realize the maximum economic returns because they are downgraded in quality. Waste of this sort, constituting a veritable drain on national wealth, is a costly luxury a developing country can ill afford.

Tanning

The precise origin of tanning is lost in antiquity, but there is evidence that the art was practised over 5 000 years ago in Egypt, China and India. The ancient craft, long operating by rule-of-thumb, later developed into the technology of modern manufacture. But it is indeed a far cry from the crudely treated skins worn by cavemen to the high-pressure leather gear of the first spacemen; from the leather shields of the Roman centurions to the leather gauntlet used by modern nuclear scientists for protection against radiation hazards; and from the primitive use of hides and skins to the most sophisticated applications in medical research and plastic surgery. Tanning of hides and skins is geographically one of the most widely dispersed industries in the world, providing gainful occupation to millions of people. The two most commonly practised methods of tanning today are vegetable (bark) tanning and chrome tanning. Vegetable tanning, one of the earliest manufacturing techniques developed by man, is generally effected by treating hides and skins with aqueous infusions of tannins derived from nuts, barks and

directions for development

Typical leather craftsman in the Sudan

fruits such as chestnut, wattle and myrabolans. It is a relatively simple process, but slow and time consuming (15 to 60 days) and is mainly used for the production of heavy leather. Chrome tanning, a more modern technique, is efficient and quick (3 to 12 hours), but requires precise conditions and control. Chrome tanning is the preferred method for most of the "fancy" leathers for gloves, garments and shoe uppers. It depends on the tanning action of basic chromium sulfate and makes use of chrome liquor.

Potential of hides and skins

For many of the developing countries, the primary processing of hides and skins represents a major labour-intensive manufacturing subsector of the livestock industry, capable of utilizing locally available raw material and especially oriented toward export promotion and diversification as well as import substitution. These valuable raw materials are capable of stimulating the development of a number of processing industries in the rural areas. They form the basic raw material for a wide range of consumer products: from the very modest traditional village footwear to the elegant shoes and leather garments of exclusive fashion houses; from the rugged and rigid industrial and mechanical leathers to the soft and supple "peccary" gloves and "chamois" skins; from the gross mass-produced semi-processed "crusts" to the precision-finished orthopaedic leather and other derived specialities for surgical grafts and prosthetics.

Hides, skins and related by-products offer unique opportunities for initiating and fostering the industrial development of a country on any appropriate scale — large, medium, small or even cottage-scale — through both capital- and labour-intensive technologies. Indeed, the leather industries throughout the world are full of instances in which semi-mechanized individual small units have successfully co-existed with large vertically integrated modern industrial complexes. A modest bark tannery, for example, with a few basic hardwares and specializing in a specific aspect of vegetable tanning, may operate alongside a sophisticated multi-line production unit with computer-controlled machines. A master shoemaker producing a small line of custom-made shoes may still survive in an environment of automation and mass production. It is the strong fashion orientation of leather and its

diversified products which provide a place for the small establishment in all countries.

Quality

An important consideration in the hides and skins industry is quality. The quality of the basic raw material is a critical factor in determining the quality of the finished product. The many causes of poor quality of the raw material originate both from nature and from man. Among the ante-mortem factors affecting the value of hides and skins are breed, nutritional condition, age and sex of the animal and its health as influenced by climate, the disease situation and incidence of parasites. It is an irony of nature that the best dairy animals yield poor hides, sheep with a luxuriant crop of fine wool produce inferior pelts, and goats of good meat quality have second-grade skins. The condition of the available pasture and rangeland naturally controls the health and well-being of the animals reared on them and is therefore largely responsible for the quality of hides and skins and their surface condition.

The manner in which an animal dies or is slaughtered determines whether the hide or skin will come out in a wholesome condition or will suffer putrefaction and associated structural deterioration. Prominent among the man-made defects afflicting hides and skins is the reckless hot-iron branding for identification. Other blemishes occurring post mortem are loss of hide substance and cohesive strength, as well as a variety of cuts, scores and gouges caused by substandard flaying, curing, handling, transportation and storage. This sector of production therefore suffers from wasteful and avoidable losses due to lack of scientific and technical know-how and resulting in considerable depreciation of quality of the raw stock — often by 2 to 3 grades.

Bag tanning, a traditional method in the Yemen Arab Republic. The hides are sewn and stuffed with pomegranate and acacia bark and chips, and hung in the open to dry and cure

There are a number of technical and economic considerations which make the development of the hides and skins industry of special relevance to the third world. Although developing countries own more than 60 percent of the world's total livestock population, they contribute less than 20 percent to its $3 500 million worth of hides, skins, leather and leatherware production. The developed market economy countries account for almost 75 percent of the leather manufactures of the world and the centrally planned countries contribute approximately another 24 percent, both deriving the bulk of the basic raw material from the third world. As against this, the combined share of all the developing countries works out to a little over 1 percent.

Economic significance

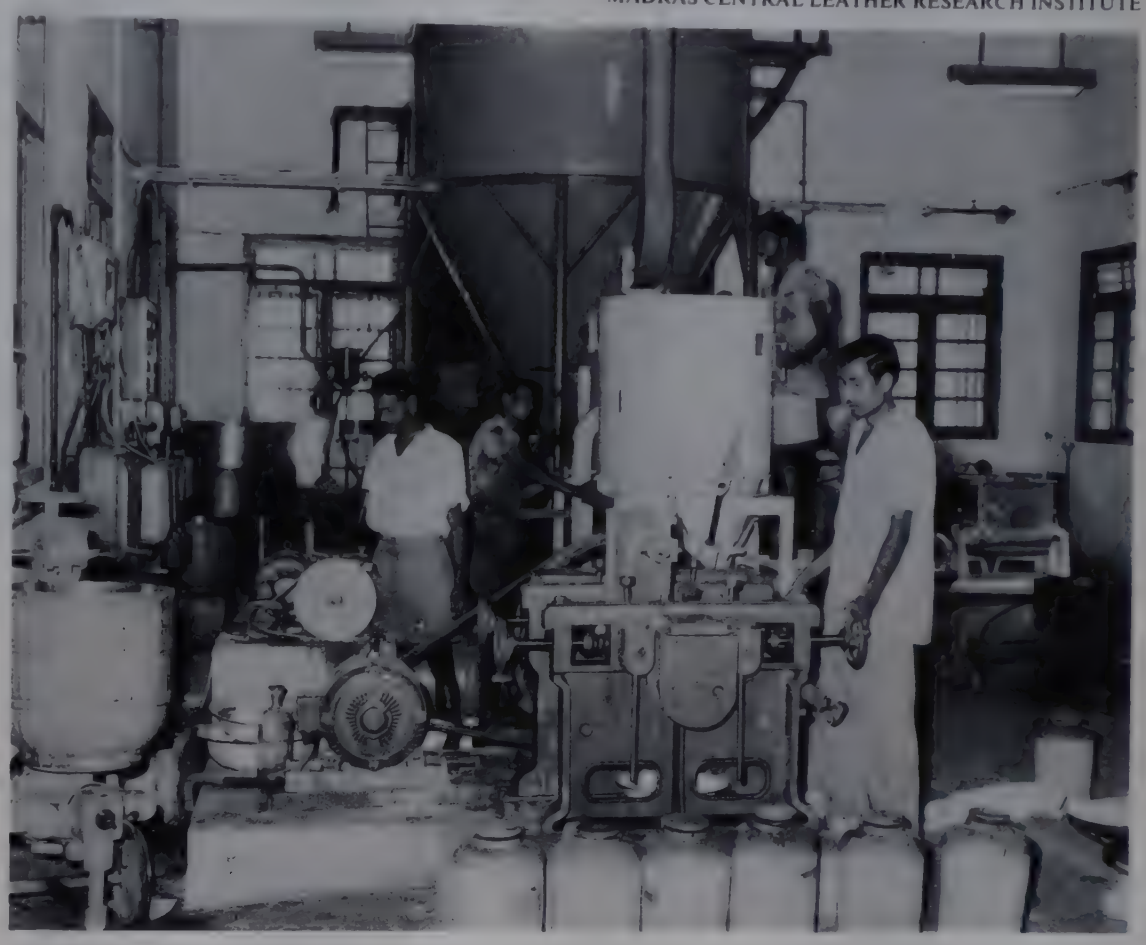
Many of the developing countries have an assured supply of hides and skins. Their processing is labour intensive. The manufacturing methods for producing the final products are comparatively simple and can be carried out without much capital investment. The labour requirement calls for unskilled or semi-skilled manpower and offers the maximum employment potential per dollar invested. It is also possible to train people easily and quickly in well-differentiated, serialized processes of leather manufacture. The relevant industries therefore lend themselves to easy establishment under third world conditions and are capable of effectively competing in the world market.

Consumer items derived from hides, skins and animal by-products meet some of the sustained needs of people today and, having a limited useful life, must be renewed fairly frequently. The increasing difficulty of obtaining suitable labour at a reasonable wage, the problems associated with importing suitable raw materials, and the mounting pressure of effluent disposal regulations are making the hides and skins industry economically less viable in the developed market economies. As a result,

the total volume of production of leather and leather manufactures in these countries has shown a marked decline in recent years. It is in this context that there is considerable scope for the developing countries to earn sizable foreign exchange through improvement of their hides and skins industries. It should be noted that when raw hides and skins are processed into leather, their commercial value is increased more than threefold; when they are made into fashionable leather goods, their value is increased three to six times. In view of this significant appreciation in the value-added component of the raw stock through tanning, finishing and manufacture, the " manufacturing element " in leather is obviously large enough to make processing economically attractive.

The demand for good-quality leather has continued to rise steeply and is limited only by the supply of quality hides and skins. Indeed, there is a chronic scarcity in the international market and hide prices have registered an unprecedented 300 percent increase in recent years. The widening gap between supply and demand has resulted in a rising demand for substitute materials. This situation poses a serious challenge to natural leather and leather products. The current availability of hides and skins from conventional sources as by-products of the meat industry is limited and inelastic, although there is substantial scope for increased production in the developing countries. This has led to greater recognition of the importance of quality in hides and skins, if genuine leather products are to retain their competitive position against substitutes.

MADRAS CENTRAL LEATHER RESEARCH INSTITUTE



A modern pilot plant manufacturing spray-dried extracts for tanning, in India

Technical assistance

The major limitations to the systematic development of the hides and skins industry in the developing countries are: lack of awareness of the economic potential; inadequate information; and lack of the requisite technical expertise and supporting infrastructure for production, training, demonstration and extension. As a result, much of the techno-economic assistance needed for the development of this resource lends itself to regional cooperative efforts. The economic, technical and social constraints are basically similar and so is the required institutional set-up. Moreover, the industry is often at a different stage of development in the different countries of a given region: some can supply natural tanning materials, chemicals and auxiliaries such as resins and finishes as well as the required machinery and equipment. Others are in a position to offer the necessary technology and provide training facilities at both institutional and plant levels. Such a diverse mixture of relatively " developing " and " developed " countries within a region facilitates integrated planning at the regional level. The lessons learned from the experience of some countries can provide guidelines for others and used to avoid the repetition of costly mistakes.

The development of an orderly marketing and pricing policy applicable to a whole region is also essential if the industry is to develop in a complementary rather than a competitive manner. There is also a patent need to harmonize the establishment of industrial processing facilities to match the growth of both domestic and export demands. Regional cooperation could also yield high dividends in technical training, which is usually specific to different regions and should take into account prevailing conditions.

The technical assistance required relates principally to the development of better methods of flaying, curing, grading and standardization of hides and skins and scientific treatment of the by-products, with a view to strengthening the raw material base of the industry. This is best achieved through pilot production-cum-demonstration units. Regulatory legislation pertaining to optimum handling, curing, preservation, storage, grading and marketing of the raw stock may

Tanning in the drum, in a modern tannery in the Philippines

also have to be drawn up at an appropriate stage. Further developments, such as the creation of a regional hides, skins and animal by-products industries service and development institute, would however depend on the organization of national services. The purpose of such an institute, which should be equipped with semi-commercial facilities for processing hides, skins and animal by-products, would be to provide technical advice and carry out adaptive research and development work in tanning, leather manufacture and by-product processing, utilizing as much of the indigenous raw material as possible. It would also develop technologies particularly geared to the needs of the small-scale and rural sectors of the industry and provide in-plant training. Much needs to be done on a sustained basis through production-oriented research, development, education, training, demonstration and extension for the scientific husbanding and harvesting of hides, skins and the animal by-product resources of the third world. A consistent strategy of planning is needed for integrated sequential development of these commodities for preventing wastage, improving quality, increasing foreign exchange earnings, raising employment opportunities and, above all, for promoting agricultural diversification by providing a viable base for a number of promising agro-industries.

Development programmes

The United Nations has sponsored hides, skins and leather development programmes in a large number of countries including Kenya, the Sudan, Upper Volta, Rwanda, Mali, Argentina, Brazil, Bolivia, Chile, Paraguay, Uruguay, Sri Lanka, Burma, Thailand, Indonesia and the Philippines. The main theme of most of these projects has been an initial resource survey followed by identification of the needs of the relevant sectors. In some countries this led to the establishment of large-scale Special Fund projects which were operated for several years. A number of training-cum-development institutes were also established. For example, in Iran, a hides, skins and leather institute was set up to serve a growing export-oriented industry, through training, demonstration and applied research and by providing technical backstopping to the emerging problems of quality control, grading and marketing. The hides and skins dem-

Drying rawhide at the Petrolina Industrial Centre, in the San Francisco river basin in Brazil

onstration project in northern Nigeria led to the founding of a well-equipped training centre in Zaria in close collaboration with Ahmado Bello University. The centre supported a pilot tannery and a control laboratory and has continued to serve the needs of the sector through adaptive research and development. It has also provided technically qualified Nigerian staff for manning the country's modern leather industry. In Somalia, a hides, skins and leather institute has been set up in Mogadishu, with a sub-centre in Hargheisha for hides and skins improvement work. Special emphasis is placed on ensuring optimum utilization of animal by-products in feed formulations and in the preparation of high-value organics.

Some of these institutes may ultimately develop into regional institutes and may establish links with other institutes in both developed and developing countries. Already, inter-institutional links have been effected between the institute in Kabete, Kenya, and the National Leather Sellers' College, London; between the institute in Tehran, Iran, and the Central Leather Research Institute, Madras, India; and between the institute in Pendik, Turkey, and the College of Technology, Northampton.

Projects under consideration

Typical among the projects currently being considered under the development programme is an animal by-products utilization project in India where about US$70 million are lost annually due to waste of these materials. Tanzania, Burundi, Zaire, Pakistan, Bangladesh and Nepal are among the other countries with a substantial potential for hides, skins and by-products development that are expected to receive assistance under United Nations and other development programmes. An expert group meeting is scheduled to be held in Latin America to review the prospects and possibilities of optimum mobilization of the continent's resources in this sector, and to draw up an integrated plan for phased development in the context of prevailing constraints and bottlenecks in the field. All of these activities have, as their objective, the effective use of biological raw materials of very considerable economic value that would otherwise go to waste, creating problems of environmental pollution and health hazards.

EARLY WEANING OF BUFFALOES IN EGYPT

Early weaning reduces the amount of milk consumed by the calves. This not only releases more milk for human consumption, but also helps to keep prices for milk and milk products at reasonable levels, and reduces the cost of rearing the calves during their nursing period. It also facilitates the raising of male calves to a liveweight of about 400 kg, for slaughter at 16 to 18 months.

Early-weaned buffalo selected as potential herd sire at the University of Alexandria experimental station

It is common practice in many tropical and subtropical countries to rear buffalo calves by allowing them to suck their dams for varying periods of time from birth to about four months of age. Thus, during the first 15 days after birth, the calves may have access to all the milk the dam produces; during the following 60 days to half the milk; and thereafter, until weaning at around 120 days, to about one quarter of the milk. The quantity of milk so consumed by the calf may range from 230 to 700 kg, depending on the level of milk production of the dam. The economic need to sell liquid milk and milk products has resulted in many buffalo farmers slaughtering or otherwise disposing of their male calves together with a smaller number of female calves at an early age — usually at about 30-40 days, but varying with the size of the calf. Sacrificing several million calves annually at such an early age is without doubt a great loss in view of the serious world meat shortage.

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Finding solutions

To ameliorate this situation several attempts have been made to lower the cost of rearing buffalo calves during the suckling period. The early efforts of the Alexandria Experiment Station in Egypt, for instance, involved restricting the intake of whole buffalo milk to 340 kg during the first 126 days of the calf's life through pail feeding. During the last few years, however, early weaning with even greater restriction of whole milk consumption has received greater attention because of the possibilities offered by milk substitutes for calf rearing. The substitutes are often based on dried milk and milk products, but the high price of these products in most buffalo-raising countries makes the adoption of milk replacers for feeding buffalo calves impractical. The use of limited amounts of buffalo milk supplemented by adequate quantities of roughages and concentrate dry meal at an early age appeared to offer better prospects of success, and much work has been done along these lines. It is based on the system that is now widely adopted of rearing cow calves on dry feed from about 3 to 5 weeks of age. The basic principle underlying this system involves the induction of adult type rumen function in the calf at an early age by gradually forcing the calf to eat a sufficient quantity of solid feed, roughage of low fibre content, and simple grain mixtures (Preston, 1956).

The objectives of early weaning are:

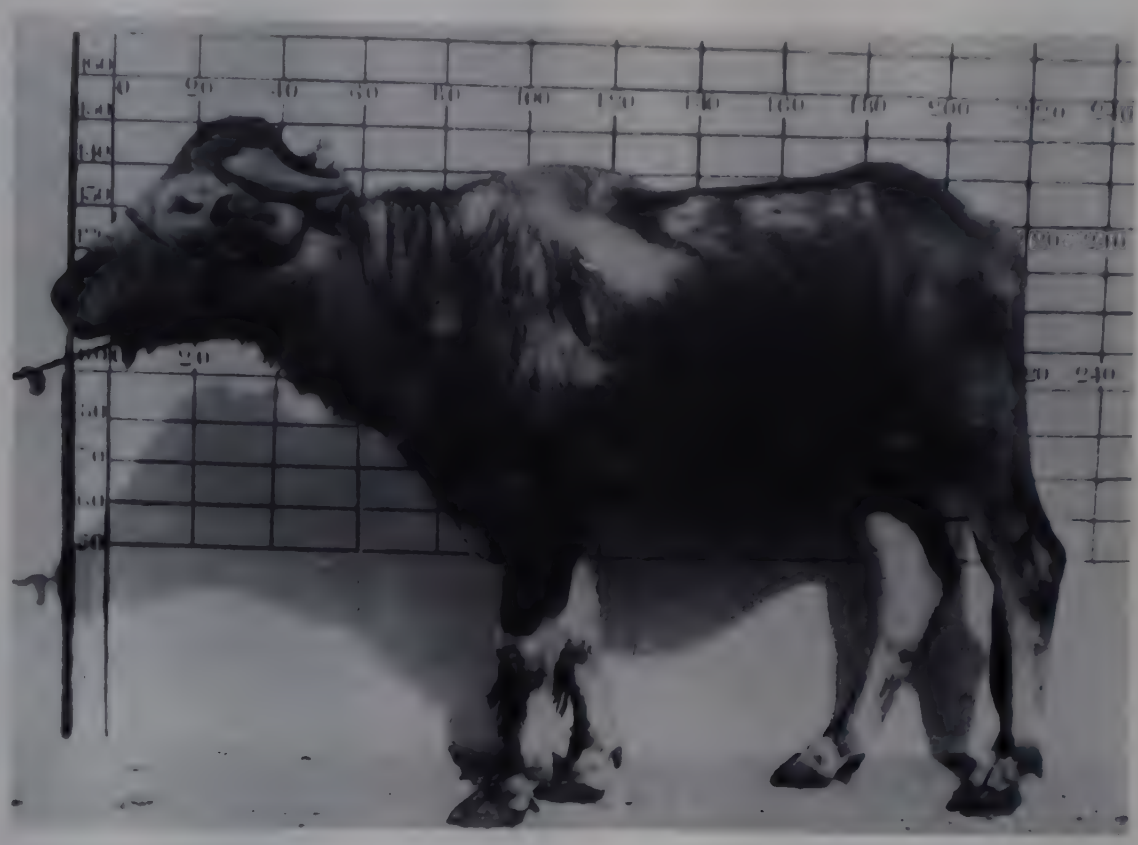
— to reduce the amount of milk consumed by buffalo calves and thus help keep the price of milk and its products at a reasonable level;

— to reduce the cost of rearing buffalo calves during the nursing period;

— to facilitate the raising of male buffalo calves for meat production, to be slaughtered at 16-18 months of age at a liveweight of around 400 kg;

— to raise more females capable of breeding at an early age.

by I.A. Ahmed
and K. el-Shazly



Left: Early weaners 9-12 months old. Above: Early-weaned yearling buffalo bull calf

Ahmed and el-Shazly (1960) attempted to apply to buffalo calves the same system of early weaning successfully used by Preston (1956) with cow calves, but soon found that it had to be modified for buffalo calves. A series of experiments were therefore carried out using some 300 buffalo calves, male and female, over a number of years. The calves were either born on the farm of the University of Alexandria or purchased from the market at the age of 10-17 days. They were allowed 70-160 kg of milk over a period of 31-61 days, while late-weaned calves received 340-420 kg whole milk in 90-120 days. In the preliminary experiments concentrate feeding was introduced at the age of 18 days, whereas in the later ones the calves had access to this feed from 4-7 days of age. The concentrate mixture used up to the time of weaning (at 45 days) was composed of energy-rich constituents based on grains, and had a TDN value of over 70 percent and a digestible protein content of over 13 percent. After weaning, however, a lower priced concentrate mixture made up principally of cottonseed meal and rice bran, and in some cases of other ingredients, was introduced gradually to replace 10 percent of the pre-weaning concentrate feed at weekly intervals. Some examples of the starter ration and of the lower priced concentrate ration are set out in Table 1. All the rations were supplemented with antibiotics, vitamins and minerals.

A limited amount of a good quality green roughage, berseem (*Trifolium alexandrinum*), sweet Sudan grass (Sudan grass × *Sorghum saccharatum*) or berseem hay, was also introduced at about the same time as the starter concentrate mixture (i.e., at 4-7 days). However, it was noted that unlimited supplies of roughage, although helping to reduce concentrate feed consumption, lowered energy availability and adversely affected growth.

These experiments served to elucidate the following facts:

— Comparable growth rates can be obtained with buffalo calves even when the quantity and duration of whole buffalo milk fed varied from 340 kg in 126 days to 123 kg in 61 days and 103 kg in 45 days (Khoury *et al.*, 1967; Borhami *et al.*, 1967a), provided that the calves had access to supplementary concentrate feeds and good quality roughage from an early age.

— The depression in growth rate that occurs for 2-3 weeks after weaning at 45 days is accompanied by a parallel depression in rumen total volatile fatty acid concentration; the addition of tallow or a mixture of acetic-propionic acids to stimulate rumen conditions did not produce any improvement in growth (Khoury *et al.*, 1967; el-Shazly *et al.*, 1967).

— The administration of vitamin E (alphatocopherol) in the form of intramuscular injections or orally or in the form of rice germ meal did not contribute to better gains.

— The use of fish meal and dried milk powder in the starter ration did not produce any improvement in growth rate; the introduction of linseed meal and pea seeds likewise did

The three photos on this page are of early-weaned buffaloes (from top to bottom) 276, 289 and 319 days of age, and weighing 241, 278 and 353 kg, respectively

not have any significant effect (Mesbah *et al.*, 1972).

— Rations containing maize stimulated better growth, gave a higher feed efficiency and were more economical than those where part of the maize was replaced by broken rice grain (Borhami *et al.*, 1967a).

It may be concluded from the above that early weaning of buffalo calves could be successfully achieved in 45 days on 103 kg whole buffalo milk and on an energy-rich concentrate mixture introduced 4-7 days after birth. A limited amount of good quality roughage should also be introduced at about the same time. Water should always be available. There is no significant difference between early-weaned calves and those weaned at 120 days on 340 kg milk, and although the early-weaned tend to lag behind late-weaned in weight gain, in some cases they reach almost the same weight at 4 months; in others early-weaned calves surpass late-weaned ones. Mortality rates are generally on the higher side for late-weaned calves. An important factor that affects the growth rate of calves, especially those weaned at an early age, is care and management; other nutritional factors tested seem to be of secondary importance.

The cost of rearing calves is perhaps the most important single advantage of early weaning. The cost of 1 kg total digestible nutrients in whole buffalo milk is about 4 to 12 times that in concentrate mixtures. Thus, the cost of 1 kg liveweight gain for calves weaned at 45 days on 103 kg milk is about 28-47 percent lower than that for calves weaned at 120 days on 340 kg milk.

Effect of early weaning on rumen development

It has long been established that volatile fatty acids in the rumen sti-

mulated the early development of papillae in number and size (Sander *et al.*, 1959), while bulk encourages the development of rumen wall muscles (Smith, 1961).

Most of the early-weaned calves in the buffalo experiments outlined above had higher VFA and microbial N concentration in the rumen juice than late-weaned calves. These support the rapid development of rumen function in early weaners. Another indication of this is the decrease of blood glucose levels which was confirmed for early-weaned buffalo calves (Borhami *et al.*, 1967b).

It is clear therefore that buffalo calves do benefit from early weaning systems through improvements in the efficiency of rumen digestion.

Effect of early weaning on the performance of adult animals

General observations on the performance of early-weaned animals showed little variation from that of late-weaned ones. However, it was considered necessary to assess the effect of early weaning on the performance of adult buffaloes in planned experiments.

The results of these experiments (Table 2) showed that there were no significant differences in growth rate at 125 days between early and late weaners, nor were there differences in feed efficiency (kg TDN/kg gain). There was a greater mortality among the late-weaned groups, which may be attributed to the greater incidence of diarrhoea. Cow calves which were weaned at 31 days using the same starter and fed a high concentrate ration from 125 days until slaughter grew at a faster rate and the cost of feeding in their case was 20 percent lower than that of buffalo calves. They reached slaughter age at 480-540 days, depending on the percentage of native blood in the crosses (native × Friesian).

There was a 26 percent reduction in the cost of feeding of buffalo calves during the whole period, mostly due to reduced milk consumption. Dressing percentages were similar for both early- and late-weaned calves (52.5 and 53.7 respectively). A score card of

TABLE 1. Composition of some typical concentrate mixtures

Ingredients	Mixtures				
	1	[1]2	3	4	[1]5
	Percent				
Maize	35	—	20	25	—
Barley	10	—	10	5	—
Broken rice	—	—	20	—	—
Rice bran	—	65	—	—	31
Molasses	8	—	8	8	5
Pea seeds	—	—	—	15	—
Beans (*Vicia faba*)	30	—	20	25	—
Linseed meal	15	—	10	15	—
Cottonseed meal	—	32	10	5	61
Calcium carbonate	1.5	2	1.5	1.5	2
Mineral mixture [2]	0.5	—	0.5	0.5	—
Common salt	—	1	—	—	1
TDN %	74.00	71.90	72.80	70.80	66.10
Digestible protein %	13.60	16.10	13.09	15.80	21.50

[1] Mixtures 2 and 5 were used to gradually replace mixtures 1 or 3 and 4 respectively from 45 days. — [2] 307 g ferrous sulfate, 100 g ferric sulfate, 1 g iodine, 10 g copper oxide, 50 g potassium chloride, 10 g manganese sulfate, 3 g zinc oxide, 10 g magnesium sulfate, 1 g sodium borate and 1 g cobalt chloride mixed with 50 kg common salt.

TABLE 2. Effect of early and late weaning on performance to 400 kg liveweight

	Early weaning	Late weaning
Age at weaning (days)	45	123
Number of calves	24	24
Mortality	0	8
Average daily gain (kg)		
To 125 days	0.30	0.32
From 125 to 363 days	0.72	0.73
From 363 days to slaughter	0.79	0.80
Conversion rate (kg TDN/kg gain)	5.15	4.95
Cost per kg gain (U.S. cents)	21.0	28.0

TABLE 3. Suckling schedule for early-weaned buffalo calves

Days	System of suckling	Males	Females
		Kg whole buffalo milk	
0-11	Complete udder	65.5	65.4
12-32	Two quarters	69.5	67.6
33-45	One quarter	22.4	22.6
	Total	157.4	155.6

TABLE 4. Average liveweight (standard deviation in parentheses) daily gain, feed conversion and cost of gain

	Male			Female		
Age at weaning (days)	45	45	90	45	45	90
Number of calves	9	6	4	7	5	7
Liveweight (kg) at:						
Start	35.9 (4.3)	34.8 (6.3)	40.0 (0.5)	32.4 (4.3)	35.3 (3.4)	33.8 (3.1)
120 days	110.7 (10.4)	111.0 (21.5)	130.7 (9.7)	102.3 (8.0)	106.0 (14.3)	120.0 (9.4)
12 months	330.8 (24.6)	338.3 (33.8)	360.2 (43.0)	293.8 (17.2)	311.6 (33.6)	316.4 (30.8)
Age at 400 kg (days)	438.0	432.0	412.0			
Age at 350 kg (days)				438.0	413.0	409.0
Daily weight gain (kg):						
To 120 days	0.62	0.63	0.76	0.58	0.59	0.72
121 days to 12 months	0.92	0.95	0.96	0.80	0.85	0.82
12 months to 400 kg	0.89	0.86	0.76			
12 months to 350 kg				0.72	0.72	0.69
TDN intake (kg)	1 503	1 487	1 484	1 275	1 186	1 214
Feed conversion [1]	4.13	4.07	4.12	4.02	3.79	3.84

[1] Kg TDN/kg gain.

assessment (Preston *et al.*, 1963) modified to suit the Egyptian consumer's taste, which refuses high fat content in meat, had higher values for buffalo (63.3 and 64.5) than for cross-bred cattle (45.1 and 48.3) (el-Naggar *et al.*, 1970).

Early weaning and natural suckling — effect on adult performance

Pail feeding — which requires special hygienic measures — is not practised by small farmers who keep buffaloes. It was therefore important to develop a system of early weaning to suit the small farmer and at the same time encourage him to keep the calf after 40 days.

In this system (see Table 3), 150-160 kg milk were suckled by calves in 45 days. Starters containing 13.6 to 13.8 digestible protein were used until 45 days and then gradually replaced by lower priced concentrate mixtures to 120 days. The results (Table 4) showed that the daily gain and feed conversion of the early-weaned calves were poorer than those of late-weaned calves during the first four months (0.63 v. 0.76 kg), due to the fact that the latter were receiving a concentrate supplement from 2 months of age. Differences were significant only for female calves (0.58 v. 0.72 kg) but the differences in weight were not significant from birth to slaughter for males and to the time of first conception for females. Slaughter weight of 400 kg was reached in 422 to 438 days for early-weaned calves and in 412 days for late-weaned ones. No differences were noticed for dressing percentage (54 percent), muscle content of carcass, or composition of the tenth rib. Hindquarters weighed slightly less than forequarters, resulting in a lower score of 58 and 57 for early- and late-weaned buffaloes respectively.

The age at first conception was 15.7 and 15.5 months for the early and late groups. All females gave birth to normal calves.

Conclusions

Early weaning of buffalo calves can be successfully undertaken by pail feeding 103 kg. whole buffalo milk or through suckling 150-160 kg of milk in 45 days. In pail feeding, growth rate during the first four months is limited to 0.33 kg/day. Greater improvements in average daily gain can be obtained when natural suckling is employed. This confirms the overriding importance of care and management in calf-rearing.

Since weaning causes an element of stress to the calf, such stress can be particularly dangerous in the case of early weaning, especially during the two to three weeks immediately after weaning and until the calf can consume enough concentrate feed.

The most important advantage gained from early weaning is, of course, the significant reduction in feed cost, which is more than one third of the total cost during the first four months.

The effect of early weaning on the performance of the calf when it becomes adult seems to be favourable as a result of early rumen development, and any ill-effects that early weaning might have had during or immediately after weaning appear to be overcome later.

There is considerable scope for the improvement of early weaning using the pail feeding system in order to reach Ragsdale's standard growth rate of 0.59 kg/day (Preston, 1956).

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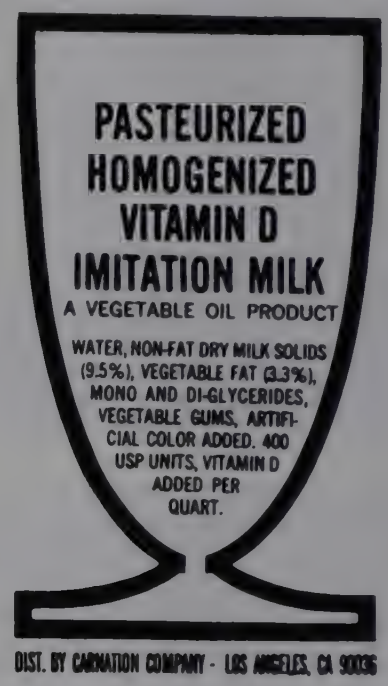
IMITATION MILKS
and imitation milk products

by F. Winkelmann



DESIGNS FROM HALF-GALLON CARTON OF CARNATION PRIZE IMITATION MILK

The Code of Principles concerning milk and milk products (FAO/WHO, 1973), which was elaborated by a committee of government experts on the basis of a draft prepared by the International Dairy Federation (IDF), defines imitation milk and imitation milk products as commodities which are likely to lead the purchaser and/or consumer to suppose that they are milk, milk products or composite products as referred to in Articles 1, 2 and 3 of the Code, but in which a milk constituent has been replaced. The Code prohibits these products to be labelled and/or presented in a manner which is likely to lead the purchaser and/or consumer to suppose that the products are commodities as referred to in these articles, with the proviso that the purchaser and/or consumer is adequately informed if such products are either designated by the name of the product preceded by the word " imitation " or by a distinct name and/or description indicating the true nature of the principal raw materials used.

The most important imitation milk products, both in quantity and in world-wide distribution, are the filled milk products. " Filled milk " is " any milk, cream or skimmed milk, whether or not condensed, evaporated, concentrated; powdered, dried or desiccated, to which has been added, or which has been blended or compounded with any fat or oil other than milk fat, so that the resulting product is in imitation or semblance of milk, cream or skimmed milk, whether or not condensed, evaporated, concentrated, powdered, dried or desiccated. This definition shall not include any distinctive proprietary food compound not readily mistaken in taste for milk or cream or for evaporated, condensed, or powdered milk or cream " (U.S. Federal Filled Milk Act, 1923).

Milk products versus imitation milk products

An excellent summary of the major differences between milk and milk products and their imitations, and of their relative nutritional merits, has been provided by the American Academy of Pediatrics (1972):

"Imitation milk products or non-dairy 'white beverages' are being developed and evaluated in many countries where milk and other high-quality protein sources are scarce. These efforts to provide nutritional supplements and to extend the avail-

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Imitation milk products include cream and ice-cream substitutes, imitation and synthetic condensed and evaporated milk, imitation and synthetic liquid milk, and imitation cheese. The illustrations on the opposite page show four of these products: liquid and powdered coffee "whiteners" and evaporated filled milk.

able food supplies are to be commended, and research in these areas should not be stifled. If imitation milk products are to replace milk in diet, they must contain adequate quantities of the essential nutrients to approximate the qualities inherent in milk. The products available to the American population have not been consistent in offering the same nutritional benefits as fluid milk. Additional information about the qualitative and quantitative composition of these products is needed before physicians in developed countries can unqualifiedly accept them. The use of imitation milks should not necessarily be viewed as a potential nutritional hazard for the population, unless they are substituted as a formula for infants. Imitation milks can be used as a more nutritious beverage than many beverages now consumed by children. However, certain nutritional risks are likely if imitation milks are used as a replacement for milk in the diets of children in the absence of other suitable sources of essential protein, minerals and vitamins. The same may be true if these products are used in the belief at they are supplying the same nutrients as skim milk or well formulated filled milks. Informative labeling and suitable standards are needed to minimize any nutritional hazards that might result from the indiscriminate use of poorly formulated products."

Production and trade

In an IDF survey on imitation and synthetic milk products[1] including filled milk products (IDF, 1970), information from 22 IDF member countries was received in response to a questionnaire relating to the kind and volume of home production, imports, sales price, legislation and reasons for the use of imitation products. The survey was updated by two inquiries carried out by the IDF in 1970 and 1972 respectively (IDF, 1973).

From the survey it would appear that the imitation milk products which have gained the greatest prominence are ice-cream substitutes and cream substitutes (in liquid, powder and frozen form).

Ice-cream substitutes. These were reported to have a high share of the total ice-cream markets in Sweden (90 percent), the United Kingdom (75 percent), Japan (50 percent), the Netherlands (50 percent) and Belgium (45 percent). In the United States the market share of imitation ice-cream (Mellorine) was 7 percent in 1969 (15 percent of the frozen dessert market in the 13 states where Mellorine could be sold).

Cream substitutes. In Sweden about 10 percent of coffee cream sales were covered by substitute coffee whiteners. In the United States these products represented an estimated 35 percent of the market for light cream; and substitutes had captured more than half the market for whipped toppings.

Imitation and synthetic condensed and evaporaed milk. Apart from southeast Asia, which was not included in the IDF survey, little development seemed to have taken place in regard to imitation and synthetic condensed and evaporated milk. In the United Kingdon the manufacture of a "synthetic plant milk" produced primarily for vegetarians ws reported. In the United States imitation evaporated milk was produced on a relatively small scale.

Imitation and synthetic liquid milk. In the United States sales of these products were reported to represent no more than 0.3 percent of the market. "Synthetic" milk had gained little acceptance because of poor flavour (despite the fact that it was cheaper than fresh milk, the retail price being about 75 percent of the price of liquid milk). A considerable quantity of imitation (filled) milk was produced in Mexico City, 250 000 litres being sold daily at subsidized prices. In India, industrial-scale trials with a "vegetable toned milk" (Miltone, formerly "Lactone") were being carried out with the assistance of UNICEF and in Chile similar trials were in progress with a "milk" based on fish protein and fish oil.

Imitation cheese. Based on skimmed milk and vegetable fat this product was reported to have captured 2 percent of the Swedish cheese market. Soybean curd (tofu) was reported to account for 90 percent of the soy protein consumption in Indonesia and Japan. In the Japanese product, the fat component was partly milk fat and partly non-milk fat. Some soy protein was used in the United States in making Cheddar cheese, and work on imitation cheese-spread based on peanut protein was undertaken in India.

The most important items in international trade in imitation and synthetic milk products appeared to be imitation creams (including coffee whiteners) and imitation milk powder (including baby food).

Filled milk products in Asia

While the replacement of milk fat in other milk products might move at a slow pace in western Europe, where traditionally milk and milk products have been consumed, experience with "filled" milk in the Philippines, where it has captured 85 percent of the market, shows that production of "filled" milks is likely to become more and more important for the following reasons:

[1] Synthetic milk products are those which contain no dairy products although some include sodium caseinate as an ingredient

PHOTO: THE BORDEN COMPANY A/S, DENMARK

PHOTO: UNILEVER N.V., ROTTERDAM

In most countries, the price of vegetable fats is two to three times lower than that of milk fat. This has a direct bearing on the manufacture of products with a high fat content, such as whipped toppings, imitation cream, imitation ice-cream and coffee whiteners. Consumer convenience in terms of longer keeping quality of products like whipped toppings and coffee whiteners also plays an important role. Concern over the presumed relationship between consumption of animal fats and cardiovascular diseases is another reason for the progress of "filled" products. Most of these products which have gained a sizable share of the market in developed countries are manufactured by big enterprises.

In developing countries which produce vegetable fats and import the greater part of their milk products, substitution of milk fat by vegetable fat is increasing. The reason for "filled" milk manufacture in Asia generally has been partly economic and partly the desire of the Asian countries to utilize their own raw materials, such as coconut, maize or palm oil, to reduce the amount of foreign exchange required for import and to increase the utilization of their home-grown products.

Thailand, which prior to 1971 used only milk and milk products (i.e., all its recombined milks utilized butterfat), has now reached a point at which approximately 90 percent of the fat content of the milks used is vegetable oil. Some are straight vegetable oils while others are used in conjunction with butterfat.

In the Khmer Republic there are some full milk products on the market and some are a blend of butterfat and vegetable fats.

In Malaysia there has been a tendency to switch to vegetable oil and, although this has been slow, the Government of Malaysia has been urging companies to use home-grown palm oil.

Indonesia is at present using only butterfat in its recombined milk, but it is believed that there are moves afoot to introduce filled milk.

Most filled products are made with coconut oil and skim milk (in liquid or dried form), and a base mix which may contain mono- and di-glycerides, sodium caseinate, corn syrup, soy protein, carrageenan, starch, artificial colouring and flavouring. Vitamins may also be added. The bulk of these products are filled evaporated and filled condensed milk.

Estimates of demand substitution

The impact which imitation milk might have on the consumption of milk and milk products appears to be of particular interest to the dairy industry in developed countries where the proportion of locally produced milk undergoing heat treatment and processing is already high, amounting to 90 percent or more in northwestern Europe, Australia, New Zealand and North America, and 50 to 65 percent in eastern Europe and the U.S.S.R.

However, the estimates of milk processing in developing countries presented in Table1 suggest that by 1980 nearly a quarter, and by 1990 almost one third of the milk produced in developing countries might be processed. The Latin American region is expected to surpass the 50 percent mark in the early 1980s.

One reason for increased production of imitation milk and milk products is the high retail price of milk and milk products in these countries and the low purchasing power of large sections of the population. The desire to reduce milk product imports to save foreign exchange, while at the same time attempting to raise standards of nutrition, might also induce governments to import and/or produce imitation milks. This may result in the exploitation of the potential for oilseed production as a source of fat and protein for imitation milk and milk products. In countries with petroleum and/or gas resources, this potential might also be used for the manufacture of single-cell protein (SCP) for animal feeding, releasing oilseed protein for human consumption, including imitation milks. The use of SCP for human food might also be considered by some governments as a long-term objective. The pressure of increasing population on the land available for agricultural purposes in the densely populated areas of the world might discourage high priority being given to the development of a dairy industry based on local milk production. Instead, there might be support for the establishment of a food industry using local fat and protein products. As a consequence, governments may have no particular interest in protecting local milk production and they may also not be prepared to issue restrictive legislation against imitation milk and milk products. The suspension of the Filled Milk Act in the United States might also induce governments to take a liberal attitude toward filled milks. But in the light of the large

TABLE 1. Milk processing in developing regions

Region	Estimated milk processed in 1970		Projections for 1980		Projections for 1990	
	Production	Processed [1]	Production	Processed [1]	Production	Processed [1]
	Million tons					
Africa	5.6	0.3 (5%)	7.5	0.8 (10%)	10	2 (17%)
Asia	37.0	1.9 (5%)	46.3	4.6 (10%)	59	10 (17%)
Latin America	24.0	9.6 (40%)	34.2	16.1 (47%)	44	24 (55%)
Near East	12.4	1.2 (10%)	16.7	2.5 (15%)	21	4 (20%)
TOTAL	79.0	13.0 (16%)	104.7	24.0 (23%)	134	40 (30%)

SOURCE: FAO, Commodities and Trade Division, Milk and Milk Products Team, 1973, Working Paper, *World Market Outlook for Milk Products*. DDI:G/73/31 - Industry Cooperative Programme.
[1] Figures in brackets refer to percentage of milk production that is processed.

TABLE 2. Assumed levels of market penetration by dairy substitutes in the United States by 1980

Dairy product	Level of penetration	
	Medium	High
	Percent	
Fluid whole milk	3	10
Cream	10	25
Low-fat milk	3	10
American cheese	3	10
Other cheese	3	10
Evap. whole milk	2	7
Cond. whole milk	2	7
Ice-cream	3	10
Ice-milk	3	10

SOURCE: U.S. Department of Agriculture, Economic Research Service, Market Research Report No. 947, p. 57.

projected gap between demand and output for milk in developing countries, imitation milks might be expected to close part of this gap rather than directly affect local milk production in these regions.[2] There would also be sufficient supply for increased filled milk production if alternative sources of protein feed for animals such as SCP become more readily available and more milk could be released for human consumption. In western Europe alone over 1 million tons of skim milkpowder and almost 10 million tons of liquid skim milk are at present fed to calves and pigs.

A high level of use of imitation milk and milk products assumes far-reaching changes in the technology of producing milk substitutes: no legal restrictions; cheap raw materials for milk substitutes; and good consumer acceptance of the imitation products. It is likely that in developing countries with a milk recombination industry, imitation milk products would first penetrate the sector of recombined milks (replacement of butterfat imports by locally produced vegetable oils) rather than affect local (raw) milk production.

The substitution of milk and milk products in Oceania is estimated to be negligible because of the low retail prices for milk and milk products and the market protection measures which are likely to be implemented in Australia and New Zealand should attempts be made to introduce substitutes.

An example of the assumed levels of market penetration by individual imitation milk products by 1980 for the United States is given in Table 2.

Protein raw materials for the manufacture of imitation milk products

Animal proteins. Ingredients in imitation milks are skim milk powder, which is essential for the manufacture of most filled milk products, and other products derived from milk: edible casein and caseinates, co-precipitates, whey powder and whey proteins.

Whey protein manufacture is expanding as the whey disposal problem is becoming increasingly acute through expansion of production and the enforcement of anti-pollution laws. Increasing whey powder prices have strengthened the trend to whey processing rather than its treatment for sewage. Special whey protein products prepared by means of modern membrane processes (reverse osmosis, ultrafiltration and electrodialysis) are of interest for high-priced products such as infant formulae.

The only other animal protein used in imitation milks appears to be fish protein concentrate (FPC). Commercial production of imitation milk using FPC is now under way in Chile with technical assistance from FAO.

Oilseed proteins. The most important oilseed protein raw material for the manufacture of imitation milk products is soybean. An immense amount of research, particularly in the United States, has been devoted during the last 50 years to the development of soybean protein products, with the result that soy flours, concentrates and isolates are now available, with functional and nutritive properties which make them attractive to the food industry. Soy protein products are used in certain infant formulae (flours and isolates), in whipped toppings, in imitation powders (isolates) and they may replace casein in coffee whiteners because of high casein prices.

A soy protein soft drink called "Vitasoy" is successfully marketed in Hong Kong. Corn-soya-milk (CSM), a food blend distributed by USAID to feed undernourished people throughout the world, is an interesting example of combining protein sources for supplemetary purposes to arrive at a product corresponding to the nutritive qualities required.

The only other protein raw material currently used for the manufacture of imitation milk products is groundnut. A milk-like beverage called "Miltone" containing cow's milk and groundnut protein has been developed in India and UNICEF is assisting in scaling up the production of this commodity.

Other protein raw materials that may be used in the future for production of imitation milk products are cottonseed, sunflowerseed, rapeseed, leaf protein and single-cell protein. But considerable work needs to be done before they can be incorporated on a commercial scale.

The competitive position of imitation milks

The attitude of the dairy industry toward milk and milk product imitations may vary from considering such products as a challenge to regarding them as a menace. In this context it should not be overlooked that dairy companies are producing filled evaporated and condensed milk and that Miltone, the Indian groundnut protein "toned" milk, is produced in a milk plant; hence it is not always easy to draw the line between the manufacturers of milk products and those producing milk product imitations. Especially in countries with a highly

[2]According to FAO agricultural commodity projections made on the assumption of constant prices and policies, demand for milk and milk products will exceed production by some 20 million tons of milk equivalent on the world level in 1980, with the gap in the developing countries alone reaching some 15 million tons.

developed food industry, milk will increasingly be used as raw material for this industry — that is, there will be a rising demand for milk constituents combined with other foods, rather than for conventional milk products and milk in its original composition.

The competitive position between the industries manufacturing milk products and their imitations in a given country will also depend to a great extent on the position taken by the government toward protection of milk producers, or, in developing countries, on the importance attributed by governments to dairy development.

A government of a developing country which does not allocate priority to dairy development might not be inclined to issue regulations restricting the manufacture and marketing of milk product imitations. This might even be true for governments wanting to support dairy industry development. They may wish to provide low-income groups with less expensive products, using locally produced ingredients (especially vegetable oils for filled milk) in the preparation of imitation milk products; or they may wish to stretch the local milk supply by "toning," replacing skim milk powder by vegetable protein, as in Miltone.

Closing milk production gap

Taking into account the projected shortage in 1980 for milk which amounts to more than 15 million tons milk equivalent in developing countries (the balance between effective demand for human consumption and production in these countries), imitation milks could play a very useful role in closing part of the projected gap between demand and production.

Regulations creating more favourable manufacturing and marketing conditions, such as the abandonment of the Filled Milk Act in the United States, and changes of technology and marketing practices are likely to result in an increasing production of imitation milk products. To be successful under commercial conditions imitation milks and imitation milk products:

- must be profitable for the producer and the distributor;
- must have intrinsic qualities that will appeal to the consumer (appearance, texture, flavour, etc.) and must be attractively presented (packaging, size, etc.);
- must be backed by an experienced and skilled marketing organization which can promote the product and exploit its appeal to the public.

A number of products such as coffee whiteners, whipped toppings, filled evaporated and filled condensed milk and certain infant formulae have met these requirements. It would appear that in most cases the use of a vegetable fat less costly than butterfat, with appropriate flavour characteristics, has played a major role in the development of the products.

Replacement of skim milk powder, or, more generally speaking, of milk protein, has proved to be more difficult. Generally speaking the position of milk protein does not seem to be threatened on a short-term basis. The danger which could threaten this position is the widening gap in research development between milk protein and vegetable protein, especially soy protein. Soy protein development has advanced very rapidly, largely due to the great volume of research undertaken, and, owing to its lower price and adequate functional properties, it might increasingly replace casein in some imitation milk products.

However, soybeans are not at present grown in many developing countries and the situation in regard to the other two major oilseeds, namely groundnut and cottonseed, is that commercial production of edible protein products is still low or insignificant. Their high potential for edible protein products is reduced in practice by the danger of aflatoxin contamination in groundnuts and of gossypol in cottonseed. On a world market level they would have to compete with soy protein products both as regards functionality and price. The use of groundnut protein in imitation milk products may grow, as shown by Miltone. The use of cottonseed protein in imitation milk products must also be regarded as a possibility, in particular low-gossypol products obtained by the liquid-cyclone process. Government policies on import and world market prices for skim milk powder will be important factors in the use of these proteins in imitation milk products.

It is difficult to make any definite forecast concerning the use of leaf protein concentrate (LPC) and single-cell protein (SCP) in imitation milks for human consumption. It is likely that SCP will be used as an ingredient in human food in the late 1980s, while in the immediate future SCP and LPC might replace a considerable amount of oilseed meal, fish meal and skim milk powder in specialized animal feeding. This may apply to whey powder as well. More skim milk powder and oilseed protein could therefore be made available for human food, especially if governments of some major dairying countries reduced their subsidies on milk products used as animal feed. As a long-term policy, LPC and also SCP production for animal feed (and later on for food) could be envisaged in developing countries for use in national animal industries and for export.

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BOTSWANA: performance testing of beef cattle

This article describes the details of a performance testing programme for beef cattle in a developing country. Full information on the system that is now in operation in Botswana, including the computer flow charts involved, are available in a report entitled "A computerized system for rapid handling, analysis and use of beef cattle performance records," which may be obtained from the Animal Production Research Unit, Ministry of Agriculture, Private Bag 33, Gaborone, Botswana.

BY J.C.M. Trail and T.W. Rennie

1. *Performance records are used for the selection of beef cattle replacement stock in Botswana*

The use of performance testing as an aid to genetic improvement of beef cattle is well known. While in recent years there has been increasingly wider recognition and acceptance of the virtues of performance testing of beef cattle in developing countries, there has been little demonstration of how, in practice, programmes can be implemented.

The major problems for successful operation of long-term performance testing are concerned with the ease and rapidity of accurate collection, handling, analysis and use of records covering the period from birth to final disposal of the animals.

This article is concerned with these aspects of performance testing and illustrates a system in operation in Botswana for the collection and handling of beef cattle performance records. At present the lifetime records of over 5 000 cattle on 16 government ranches and the part-life

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WEIGHT SHEET

STATION:- MORALE. DATE:- 15 - 3 - 74

SIGNATURE:- N Phuti TEST WEIGHT NO. 8 .74 LBS

NUMBER	WEIGHT	NUMBER	WEIGHT
106	652	12	797
119	547	24	681
132	349	13	684
7	1107	22	744
18	1004	TEST Wt.8	74
9	873	88	541
23	922	78	549
16	748	62	601
35	900	65	584
36	1025	5	921
TEST Wt.8	75	10	890
87	724	15	942
111	575	25	822
109	550	130	250
38	1072	131	245
4	973	127	301
8	823	TEST Wt.8	75

92

TREATMENT SHEET

STATION:- MUSI. DATE:- 28-1-74.

1-1-74 Breeding Bulls No's 85 + 106 put to the breeding cow herd.

5-1-74 Cow No 306 treated with 30cc Terramycin for udder abcess.

12-1-74 All young stock deticked.

15-1-74 Breeding herd transfered to Paddock 7

27-1-74 Wild dogs killed calf No 784. Carcase buried.

N. Moyo.

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STATION Matlolakgang

HERD Tswana.

CALF No. 582

DATE OF BIRTH 28 - 11 - 73

SEX Male

DAM No. 18

DAM BREED Tswana.

SIRE No. 335

SIRE BREED Tswana.

CALF WEIGHT 74 lbs. Test Wt 3 62 lbs

DATE WEIGHED 29-11-73

DAM WEIGHT 980 lbs.

DATE WEIGHED 29-11-73

CALF DESCRIPTION Reddish Brown. White left hind-leg.

REMARKS

Normal birth, cow has good supply of milk.

N. J. Nchoka

2. *Sample pages from the monthly weight record book, the treatment book and the birth notification book*

records of over 10 000 cattle on recorded farms and artificial insemination stations are involved. The major traits recorded are reproductive performance, growth, viability and mothering ability (Animal Production Research Unit, 1974).

Under the extensive range conditions of Botswana a recording system for individual herds must permit the accurate collection of required information in the simplest possible way. In general, information is required for decision-making at both herd and national level. At herd level it is needed for the evaluation of young bulls with a view to sire replacement and sale of breeding stock; of young heifers with a view to their selection as herd replacements; and of cows in order to decide whether to retain or to cull them. At national level information is needed in order to select outstanding sires for use and further testing for artificial insemination. Data from all sources are needed to allow valid comparisons of breed types, to determine the effects of crossbreeding and to study any differences in performance of the types in different areas of the country.

Data collection

All ranch or herd recording is carried out in three duplicate books: a birth notification book, a treatment book and a monthly weight record book. A page from each book is illustrated in Figure 2. Pages are serially numbered in advance so that any misplaced records can be easily checked.

The calving season lasts for three months each year. Within 24 hours of each calving, the cow and calf are weighed; the calf is ear-tagged; and the calf number, date of birth, sex, weight, dam number, dam breed, sire number, sire breed, dam weight and any relevant comments are entered on a duplicate sheet in the birth notification book. During the calving season the top copies of birth sheets are dispatched daily to the central animal production research unit.

In this way, information on calf births can be rapidly checked and any obvious discrepancies or omissions corrected within a reasonable period of time.

Monthly weighings are carried out, all animals being starved overnight. At the beginning and end of each weighing session a nuxbered test weight is weighed and recorded to test the scales. At weighing, the animal number and the weight are entered directly into the duplicate book (Figure 3). Immediately after each weighing session the top copies of the weight sheets are sent to the central animal production research unit.

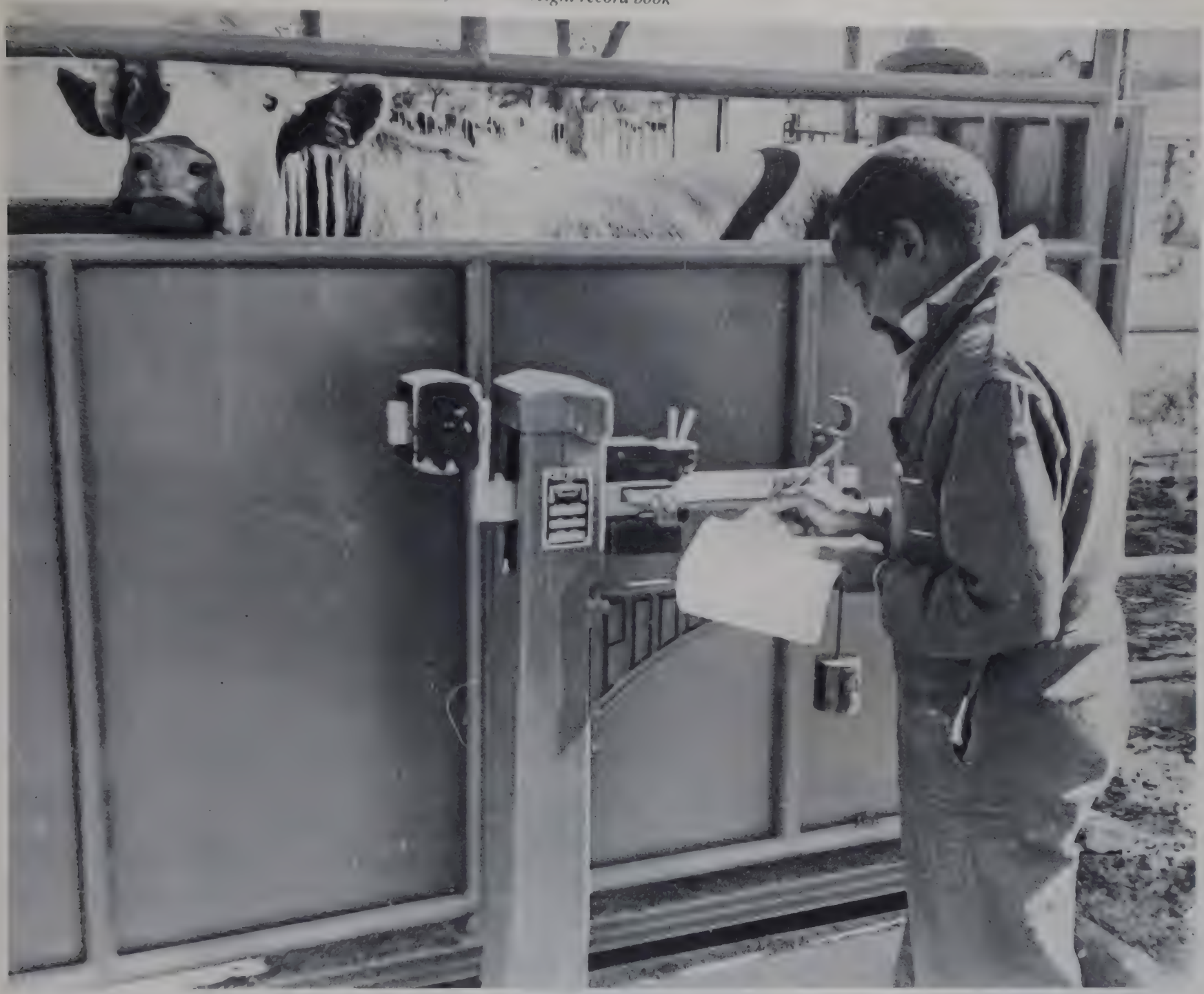
All information other than births and weights is recorded in the treatment record book. "Treatment" covers sickness, vaccination, dehorning, castration, grazing records, increase or decrease in stock other than by births, breeding reports and so on. Treatment sheets are sent at frequent intervals to the animal production research unit.

Data handling and analysis

Birth records

Birth records are checked on receipt and all details, plus details of ranch, breed, month of birth, sex, age of dam and previous parous state of dam, are entered on an appropriately laid out

3. *The animal's number and weight are entered directly into the weight record book*

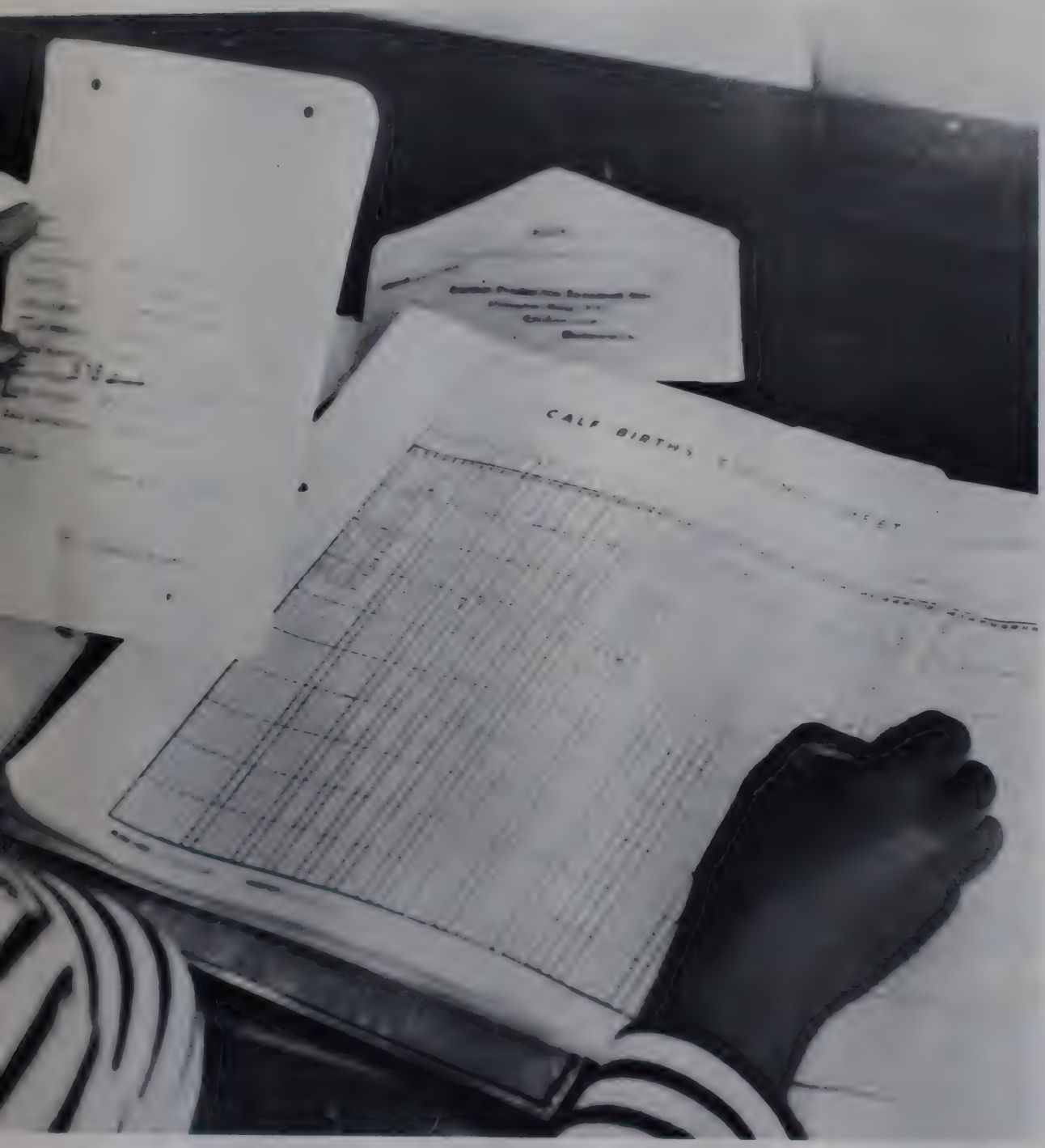


4. *Ear-tagging at birth to ensure accurate identification*

5. *Branding at weaning*

coding sheet. This operation is shown in the illustration below (Figure 6). Cards are punched and verified and, when the last calf of the season has been born, this pack is fed into the beef cattle performance recording system stored on an I.C.L. 1902 computer.

This system automatically sorts out and produces a new file for this calf crop, calculates by least squares the birth weights adjusted for environmental effects specified, and updates the main cow records with this new calf crop information. At the same time, a print-out is produced of the new calf crop and an updated print-out of the cow records. The new calf crop print-out is illustrated in Figure 9; the information produced at this stage goes as far as the corrected birth weight only. The updated cow record is illustrated in Figure 10.



Weaning weight records

Animals are weaned at 7 months of age ±2 weeks. Adjusted 210-day weaning weights are calculated on a microcomputer from the monthly weighings, and entered on appropriate coding sheets. Cards are punched, verified and fed into the system, which calculates by least squares the weaning weights adjusted for environmental effects; works out weaning weight ratings within breed types; updates the calf crop record with this information; updates the cow records with the adjusted calf weaning weights and ratings; and produces new cow and calf listings, updated to the weaning stage (see Figure 9 for weaning weight rating and Figure 10 for corrected weaning weights and weaning weight ratings).

18-month weight records

Weights received at approximately 18 months of age are adjusted by interpolation to 545-day weights on the microcomputer and entered on appropriate coding sheets. Cards are punched and verified and fed into the system which calculates by least squares the 18-month weights adjusted for environmental effects; works out 18-month weight ratings within breed types; and produces a calf listing finally updated and printed as illustrated in Figure 9.

6 *(left). Preparation of coding sheet.* **7** *(below). Weight adjustment on a microcomputer*

Deaths and removals are entered on appropriate coding sheets when received, punch cards are produced, and this information is fed into the system each time weight records are entered. The main files are automatically updated and each print-out thus has a section concerned with animals present at that time and also a section covering deaths and removals.

Use of information

Annually, at herd level, the updated listings are used to arrive at decisions on which cows are to continue in the breeding herds and which are to be culled (based on their calving performance and calf weaning weights as laid out in Figure 10); which young heifers are to enter the breeding herds as replacements; which young males are to be retained as bulls and which are to be castrated (these three decisions being based on the 18-month weight ratings shown in Figure 9). A simple code alongside each animal number is then fed into the system and results in the automatic addition or removal of selected animals to (or from) the various groups: breeding animals, other stock older than 2 years, and removals and sales.

Annually, at national level, additional information available from all sources is used to make comparisons of breed type performance. These become increasingly accurate with time. This enables logical decisions to be made and implemented through the breed types offered for sale through the Botswana Government bull distribution and artificial insemination schemes (Animal Production Research Unit, 1974).

MINISTRY OF AGRICULTURE 05/12/73

DIVISION OF ANIMAL PRODUCTION

A.P.R.U. LISTING NO. 3

STATION LEUPANE

CALF LISTING NUMBER THREE OF CALVES BORN IN 1970
PRODUCED WHEN ALL ANIMALS HAVE REACHED 18 MONTHS IN 1972

AFRICANDER BREED

CALF NO.	BREED	DATE OF BIRTH DD MM YY	SEX	SIRE CODE NO.	DAM NO.	DAM AGE	PPS	BIRTH WEIGHT	CORRECTD BIRTH WEIGHT	WEANING WEIGHT	CORRECTD WEANING WEIGHT	WEANING WEIGHT RATING	18 MONTH WEIGHT	CORRECTD 18 MONTH WEIGHT	18 MONTH WEIGHT RATING
3	1	12 10 70	1	140	C378	6	3	65	70	365	377	+ 18	608	656	+ 42
4	1	25 8 70	1	140	D412	8	3	69	78	530	326	- 45	565	591	- 23
9	1	4 8 70	1	141	D465	6	2	37	44	357	349	- 16	529	577	- 37
12	1	1 12 70	1	140	F529	6	1	60	65	568	592	+ 25	614	617	+ 3
13	1	23 11 70	1	141	A 49	6	3	64	69	365	346	- 21	567	521	- 93
14	1	20 10 70	1	141	291	6	1	81	88	417	418	+ 51	732	706	+ 92
15	1	1 12 70	1	141	C501	5	3	54	55	558	564	- 25	606	607	- 7
20	1	9 1 71	??		71	7	1	79	78	259	265	-102	569	556	- 58
53	1	22 8 70	1	138	A 28	5	2	71	80	590	586	+ 17	633	679	+ 65
55	1	31 12 70	1	138	63	8	3	78	79	585	591	+ 24	655	656	+ 42
75	1	11 12 70	1	138	71	6	5	75	77	565	589	+ 22	650	653	+ 39
80	1	28 10 70	1	140	D23A	9	1	63	68	570	571	+ 4	663	617	+ 3
83	1	25 10 70	1	138	C282	6	2	60	63	570	339	- 28	597	573	- 41
87	1	10 12 70	2	139	A 87	5	5	80	75	496	462	+ 95	808	775	+161
90	1	28 8 70	2	141	90	6	3	78	83	400	356	- 13	600	612	- 2
92	1	23 10 70	1	138	D457	5	3	70	75	372	373	+ 6	710	684	+ 70
94	1	27 8 70	1	139	D497	6	3	64	71	390	402	+ 35	619	667	+ 53
95	1	11 11 70	1	138	F527	6	3	65	68	386	403	+ 36	598	574	- 40
97	1	23 11 70	2L	141	97	6	3	81	87	352	313	- 54	611	551	- 63
104	1	21 10 70	1	145	F617	3	1	65	68	346	387	+ 20	645	639	+ 25
107	1	12 11 70	1	145	F639	3	1	70	71	295	336	- 31	569	563	- 51

MINISTRY OF AGRICULTURE

DIVISION OF ANIMAL PRODUCTION

A.P.R.U. LISTING NO. 4

STATION IMPALA

BREEDING COW LISTING
PRODUCED AT END OF 1973 CALVING PERIOD

AFRICANDER BREED

COW	BREED	DATE OF BIRTH DD MM YY	SIRE CODE NO.	DAM NO.	YEAR	PPS	COW PARTURITION WEIGHT	COW WEANING WEIGHT	CALF NO.	CALF SIRE BREED	CORRECTED WEANING WEIGHT	WEANING WEIGHT RATING
137	1	17 11 67	129	107	70	1			DID NOT CALVE THIS PERIOD			
137	1	17 11 67	129	107	71	1	937	839	536	1	337	+ 40
137	1	17 11 67	129	107	72	3			DID NOT CALVE THIS PERIOD			
137	1	17 11 67	129	107	73	2	884		633	1		
139	1	23 11 67	129	96	70	1	702	773	470	1	324	+ 36
139	1	23 11 67	129	96	71	3			DID NOT CALVE THIS PERIOD			
139	1	23 11 67	129	96	72	2	905	974	576	1	334	- 5
139	1	23 11 67	129	96	73	3	914		673	1		
170	1	17 10 68	128	25	70	1			NEW COW			
170	1	17 10 68	128	25	71	1	828	781	536	1	337	+ 20
170	1	17 10 68	128	25	72	3			DID NOT CALVE THIS PERIOD			
170	1	17 10 68	128	25	73	2	899		631	1		
176	1	25 12 67	129		70		872		479	1	336	+ 68
176	1	25 12 67	129		71	3			DID NOT CALVE THIS PERIOD			
176	1	25 12 67	129		72	2	876	865	621	1	379	+ 60
176	1	25 12 67	129		73	3	920		696	1		

9 and **10.** *Calf listing (breed, sex, previous parous state* [PPS] *are coded; weights and rating are expressed in pounds), and breeding cow listing*

8 *(below). Transfer of data to punch cards*

REFERENCE

ANIMAL PRODUCTION RESEARCH UNIT, 1974. Beef Cattle and Range Research Programme in Botswana 1970-73. A.P.R.U., Private Bag 33, Gaborone, Botswana.

World Food Conference

The World Food Conference, held in Rome in November 1974, made three important recommendations of relevance to the livestock sector. The first concerned the strengthening and expansion of programmes relating to the survey, conservation and effective utilization of animal genetic resources, and the rapid establishment of a global network. The second recommended the stepping up of cooperative research programmes on new feed resources, involving the research centres of developed countries, international and regional research institutes, and suitable institutions in developing countries. The third called on FAO to launch, as a matter of urgency, a long-term programme for the control of African animal trypanosomiasis, in cooperation with the governments of the countries concerned, interested international organizations and specialized research institutes, and with the support of bilateral and multilateral assistance agencies.

The follow-up action initiated by FAO has involved the setting up of three working groups for research in these three fields

The working group for research on breed evaluation and crossbreeding has as its objectives the definition of priorities in the evaluation of programmes within the general field of animal genetic resources, a review of work already done or in progress, recommendations of specific research programmes which should be instituted, and ways and means of undertaking these on a cooperative basis. This working group will have its first meeting in Warsaw, Poland, in June 1975 in conjunction with the twenty-sixth annual meeting of the European Association for Animal Production.

The working group for research on new animal feed resources will meet later, and will have as its objective the identification and elaboration of appropriate research programmes on new feed resources of potential use in animal production, bearing in mind current possibilities for their utilization in developing countries. It will also advise on international action for cooperative research in this field.

For the programme of control of African animal trypanosomiasis, a small coordinating unit is being established at FAO headquarters to initiate the first phase of the programme, devoted to training, pilot field control projects and applied research, in preparation for future large-scale operations. A special FAO/Industry task force has also been set up to further industry's participation in the programme. Arrangements are in hand for a meeting to be held later in 1975 of the working group for research on tsetse and trypanosomiasis control to advise on future activities, especially collaborative research with institutions engaged in this field.

XIXth International Dairy Congress — New Delhi, India, 1974

This Congress was the first of its kind to be held in one of the developing countries and was the first to give emphasis to the problems of dairy development in the third world. The organizing committee headed by dr. V. Kurien (Chairman) and Miss Amrita Patel (Secretary-General) did an outstanding job and to them is due the major credit for the success of the Congress. Some 1 500 participants from all over the world attended.

The technical programme for the Congress was divided into three streams: dairying as an instrument of social and economic change; dairy sciences; the dairy industry. Two volumes, one containing papers on the subject of dairying as an instrument of social and economic change and the other consisting of brief communications dealing with the dairy sciences and the dairy industry, were distributed at the opening of the Congress. A total of 862 brief communications were received.

The theme of the Congress — dairying as an instrument of social and economic change — featured prominently in discussions throughout the week, first in smaller groups and later at a number of plenary sessions. This provided the opportunity for participants to learn how well this theme had been implemented in India, particularly at the Kaira District Milk Producers' Cooperative Union, Anand.

The XIXth International Dairy Congress paid more attention than any previous congress to the problems related to dairy development, not only in developing countries, but in advanced countries as well. It also highlighted the role of the buffalo in livestock development in many countries and made a strong plea for the establishment of an International Buffalo Research Centre.

Three recommendations were adopted at the Congress. The first called for an increase in efficiency in the use and conservation of energy in farm and factory production, and in the use of milk and its constituents directly as human food. The second recommendation called on FAO and the World Food Programme (WFP): "Urgently to expand and develop schemes for further constructive and sustained use of milk products to foster economic and social progress." The third recommendation urged the International Dairy Federation to devote "considerably increased attention to the problems specific to developing countries."

A number of pre- and post-Congress study tours covering the length and breadth of India were organized, giving participants a unique opportunity to obtain a better understanding of the problems of dairy development in a developing country.

The next International Dairy Congress will be held in France.

Royal (Dick) School of Veterinary Studies, Edinburgh

The Department of Animal Health offers the following courses commencing in October 1975:

DIPLOMA IN VETERINARY STATE MEDICINE.
Two courses of study are available:
Animal Health — Husbandry practices, disease control, economics of preventive medicine.
Veterinary Public Health — Veterinary food hygiene, epidemiology, zoonoses.

Both sections are complemented by a review course and by a comprehensive Meat Inspection course, and by extra-mural training. The Diploma examinations are normally held after nine months of study.

M.SC. (VETERINARY PUBLIC HEALTH)
The course is concerned with the broader concepts of veterinary public health, with particular reference to epidemiology, the zoonoses and environmental hygiene and requires the submission of a dissertation on independent work or a review of literature. This course will extend over one calendar year.

Further particulars are available from the Senior Administrative Officer, Royal (Dick) School of Veterinary Studies, Summerhall, Edinburgh, Scotland.

XXth World Veterinary Congress

This Congress will be held in Thessaloniki, Greece, from 6 to 12 July 1975 under the aegis of the World Veterinary Association. The sessions of the Congress will be held on the campus of the Aristotelian University and at the International Fair of Thessaloniki. The agenda for the scientific programme is divided into 5 plenary and 18 sectional meetings. The topics for the 5 morning plenary sessions are:

1. Role of the veterinary profession in society.
2. Specialization in veterinary education, undergraduate and postgraduate.
3. The problem of meat production in the world.
4. Man, animal and environment.
5. Comparative studies in biomedical research.

Topics covering practically the whole of veterinary science will be presented and discussed in 18 sectional meetings. Summaries of the papers to be presented will be made available to registered participants together with information updated by a news bulletin published daily during the Congress.
Social entertainments and visits to places of historical and cultural interest form part of the programme.
Detailed information can be obtained directly from the Organizing Committee of the XXth World Veterinary Congress, Aristotelian University, Box No. 112, Thessaloniki, or from national representatives of the World Veterinary Association.

EAAP Annual Meeting

The 26th annual meeting of the European Association for Animal Production will be held in Warsaw, Poland, during 23-27 June 1975. The official languages of the meeting will be English, French, German and Russian. One day will be devoted to general meetings, two and a half days to meetings of the Commissions on Genetics, Nutrition, Management, Cattle, Sheep and Goats, Pigs and Horses, and one and a half days to excursions and a show. In addition a four-day excursion has been planned before the meeting and five alternative three-day excursions after the meeting. Prospective participants should write to: Polish Travel Office " Orbis ", Congress Bureau, p.O. Box 146, 00-950 Warsaw, Telex: 814728 bkorb pl.

Letter to the editor

INTENSIVE FEEDING SYSTEMS FOR BEEF PRODUCTION IN DEVELOPING COUNTRIES

Sir,

I refer to the article on "Intensive feeding systems for beef production in developing countries," by P. Auriol (No. 9, 1974). I find it difficult to accept the conclusion that feedlots are the answer to problems in developing countries and that these will not only increase meat production but make it more efficient.

In the first place the author has oversimplified the situation in suggesting that in developed countries beef is usually achieved by feeding high energy rations to young animals.

In a number of developed countries, including western Europe, Australia and New Zealand, pasture and pasture products are the basis of beef production and, even in Europe, rations containing more than 30 percent of concentrate are unusual. Since the emphasis is on export trade in beef, it should be noted that the major exporting countries are not using feedlots and the proportion of meat in the export trade derived from feedlots would be very small indeed. This is because importing countries give preference to their domestic producers and these are much better able to provide the best table beef.

The proposition that feedlot systems using high energy rations would be more efficient is based on consideration of the growth curve of steers and the proportion of total energy required for maintenance. No consideration is taken of the difference in the cost and alternative uses of different forms of energy. In many instances, extensive grazing is very low cost and there is often no alternative means of utilizing this resource.

On the other hand concentrates are very expensive and are in demand both as human food and for other forms of livestock production. In assessing the efficiency of beef production systems it is necessary to consider the overall system including the breeding herd and the steers. Since it is highly improbable that it would be possible to import concentrates to feed cattle for export, the meat-exporting countries should also consider the land required to grow the concentrate.

With respect to the use of land, the feedlot system may be efficient for the central plain of North America, where extremely cold winters and favourable summers enable crops to produce more energy than pastures. For most of the temperate and tropical regions the situation would be reversed, and the diversion of land from pasture to grow crops for beef production would probably produce less beef rather than more. There would be exceptions where industrial by-products from sugar and other industries could be used for beef production. These have been noted in the article.

A major economic problem in feeding high-concentrate rations to beef cattle is the efficiency of the beef animal relative to other meat animals such as the pig and chicken. When pigs can produce twice as much meat from feedgrain as cattle, there has to be a strong price advantage for beef. In the current glut in beef in the developed countries there is evidence that grain-fed beef can become too expensive for even the most affluent consuming countries.

The feedlot system was developed in a country and during a period when grain production was expanding at a dramatic rate. Its success was related to climate, resources and a specific domestic market. It is currently being reappraised and may be very different when the process of adjustment has been completed.

The suggestion that feedlots in developing countries may be a solution to the problem of overgrazed range lands could also be wishful thinking. If there is ignorance of sound criteria for optimum grazing of range land, this would have to be corrected by an education and extension programme. If it was not, the range lands would again become overstocked with cows.

Another generalization is that specialized systems of beef production are progressive and efficient whereas nonspecialized systems are not. I believe that the efficiency of these different types of systems would depend on the resources being used and the environment.

The management of cattle can be made more efficient by giving preferential treatment to specific sex-by-age groups according to need and, in many environments, integrated systems can be developed in which the age and condition of slaughter animals can be greatly improved. Such an approach may be more difficult to apply in a developing country but in the long term the efficiency of herdsmen in the management of the base cattle population will be of paramount importance.

On the other hand the development of a new specialized and highly capitalized section of the industry to fatten steers could be to the disadvantage of the indigenous industry as it would control the markets and profits.

Yours, etc.

A. H. Bishop
Officer-in-Charge,
Pastoral Research Station,
Department of Agriculture,
Victoria, Australia.

Proceedings of the Working Symposium on Breed Evaluation and Crossing Experiments with Farm Animals

Research Institute for Animal Husbandry "Schoonoord," Driebergseweg 10d, Zeist, the Netherlands. September 1974. 521 pages. Price D.fl. 45.00 (surface mail included).

This symposium, sponsored by the Stichting Fonds Nederlandse Veefokkerij, was organized under the auspices of the European Association for Animal Production and the Netherlands Association for Animal Production and held at the Research Insitute for Animal Husbandry "Schoonoord," Zeist, 15-21 September 1974. There were 40 participants, of whom nearly half came from the Netherlands and the Federal Republic of Germany, and the rest from ten other countries of Europe and North America and from New Zealand. The Proceedings include 35 papers divided into four sections — general, cattle, pigs and sheep. In addition each session includes a review of the papers and a summary of the discussion.

The first section includes more or less theoretical papers on the design of experiments for the comparison of breeds and crosses and on the utilization of breed differences in crossbreeding. Both Dickerson in this section and Cunningham in the cattle section suggest that the most desirable dairy cattle breeding system to exploit heterosis would be a criss-crossing scheme between two breeds which are genetically distinct but of similar performance. The difficulty is to find another breed which approaches the Friesian in productivity. In this connexion great interest attaches to two papers from Denmark which describe recently initiated crossbreeding experiments between Danish Red, Holstein-Friesian, Finnish Ayrshire, Meuse-Rhine-Yssel and Swedish Red-and-White. An alternative would be a reciprocal crossing system between two Friesian strains. To make this possible the European and American strains must be kept separate. However, the current tendency is to improve the milk yield of the European strains by grading with the American Holstein-Friesian and no fewer than five papers describe experiments on this topic. (Incidentally, the FAO cooperative experiment comparing Friesian strains is mentioned several times but is not described.)

For beef production the same two authors agree in advocating criss-crossing between two small or medium-sized breeds to produce a hybrid dam on which a terminal sire of a large breed would be used. Alternatively the maternal line may consist of a dual-purpose breed selected for milk yield; the cows not used for breeding dairy replacements (40-60 percent) can be put to a terminal beef sire. There is no shortage of breeds for both sire and dam lines and four papers give experimental results in this field.

For pigs and meat sheep, opinions are less unanimous. Dickerson recommends the use of a specific terminal sire with an F_1 or rotation-cross dam. Other writers express little enthusiasm for rotational crossing. In the main pig paper, Fewson concludes that the only competitive crossbreeding methods in pigs under European conditions are specific 3- or 4-way crosses of highly selected lines. Rotational crosses may be used on the female side for hygienic reasons but only if highly specialized sire breeds are used to produce the final crossbred for market. King would concur but points out that the best breeding system will depend on the performance of the breed used. He also advocates the use of crossbred boars.

In his introductory paper on (meat) sheep Timon suggests that crossbreeding is only useful for increasing the reproductive efficiency of a female line. Maijala, summarizing three other papers, states that heterosis is of minor importance compared with differences between breeds.

The organizers of the symposium are to be congratulated on bringing together speakers who did not mind talking about work in progress. The main speakers were excellently forthright in expressing conclusions. Above all, we are indebted to the editor (Minkema) and publishers for getting the proceedings so quickly into the hands of those who were not at the meeting.

I.L.M.

Animal management

Tierhaltungslehre. Edited by G. COMBERG and J.K. HINRICHSEN. Stuttgart, E. Ulmer, 1974. 464 pages. Price: DM88. (In German)

This book on animal management, by 14 German authors, complements the one on animal breeding published in the same series by Comberg in 1971. It is a fairly complete treatise on the art of keeping livestock under intensive conditions for the realization of their genetic potential. It starts off with a general account of the production that man demands from domestic animals and the environment the animals require if they are to perform accordingly. In a chapter on environment the factors of climate which influence well-being and productivity of livestock are dealt with. A brief introduction on animal health and disease control is followed by a chapter on animal behaviour. This is an excellent summary of the importance of observing how animals behave in order to improve their comfort.

The second part of the book deals with management of different species of livestock and poultry, including elements for planning of animal operations, housing, installations and equipment. There are separate chapters on regulation of climate in animal houses, milking techniques, waste management and animal protection.

The advances achieved in recent years in techniques for improving labour efficiency and coping with increased productivity, such as different types of cubicles for cattle housing, new systems of managing pigs in the different cycles of reproduction and growth, or mechanization of poultry houses, are covered. Discussion throughout is limited to housed animals under temperate conditions in central Europe. However, much of the basic information would also apply under other conditions. The book will be useful for students of agriculture, animal production and veterinary medicine, but the practitioner in these fields will also find it valuable for general reference.

C.G.

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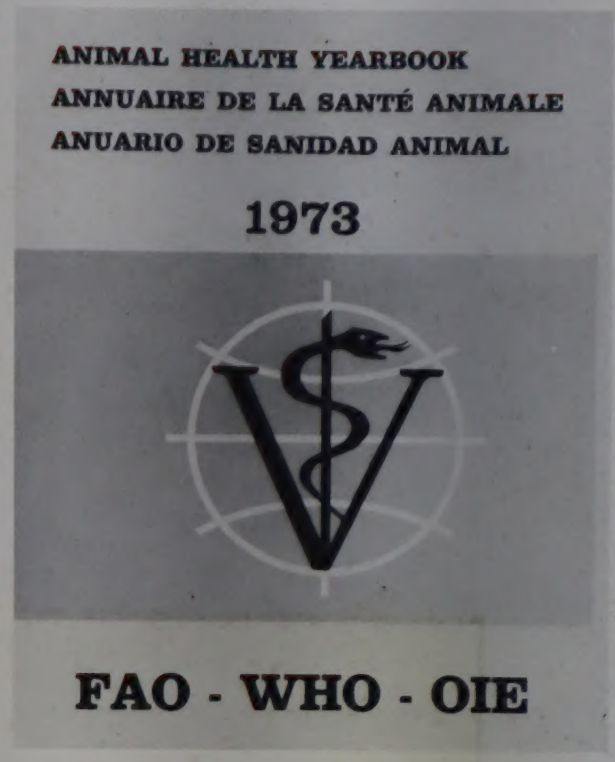
THE LATEST FAO-WHO-OIE REPORT ON WORLD LIVESTOCK DISEASES



This edition of ANIMAL HEALTH YEARBOOK is published in a reduced format. Several changes have been effected in its presentation, for the convenience of readers and in order to include as much information as possible.

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